POWER

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Realizing on the Power Show

THERE is a much abused joke about a prospect who got rid of a pertinacious canvasser for a stove that would save one half of the fuel, by agreeing to buy two of them if they would save it all.

In this Power Show are displayed apparatus, appliances and materials of many sorts, major and accessory, essential and optional.

Each and every one of these has for its purpose a saving in the power plant.

Some save time and labor, some save the cost of shutdowns and mishaps, some save material and some save fuel or steam directly.

How much of your power cost might be saved by the intelligent use of what is to be found in this collection of exhibits?

If you could pick out eight or ten of them, each of which would make even a small improvement in your over-all efficiency, the sums of their several economies might be such a proportion of the whole as to warrant consideration.

Is not going about among the exhibits with a mind receptive to suggestion, with an eye out for things that may be useful in your business, one of the best ways of realizing the benefits offered by a visit to this Power Show?

F. R. Low

New Power Plant

of the Canada Sugar Refining Co., Ltd.

Contains Many Innovations

By A. L. COLE, *Editorial Staff of Power*

Two boilers of entirely new design supply steam at 300 lb. and 70 deg. superheat to two 1,000 kw. high back pressure turbines and through reducing valve to process. A steam accumulator is used to handle widely fluctuating steam demand and permit boiler to operate at nearly constant rating and highest efficiency.

THE new power plant of the Canada Sugar Refining Company, Limited, Montreal, Canada, which was put into operation about a year ago, stands out as an excellent example of what it is possible for the engineering and operating staffs of an industrial concern to do in the way of replacing its antiquated steam and power plant with a modern and efficient one. Not only

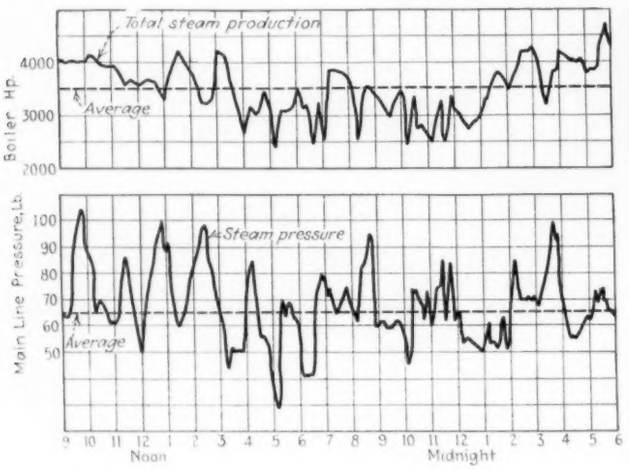


Fig. 1—Steam production and pressure curves from the old plant

was the new station constructed on the site of the old plant without interfering with the operation of the refinery, but a number of radical departures were introduced which denote clearly an advanced step in refinery power-plant practice.

At the time the plans for the reconstruction were made, the steam for the refinery was generated at 80 lb. pressure and without superheat, in two separate boiler plants, located about 800 ft. apart, requiring separate operating crews and separate coal and ash handling equipment. One plant contained two 10,000-sq.ft. horizontal water-tube boilers fired by chain-grate stokers, and the other contained twelve 2,500-sq.ft. Lancashire boilers fired by overfeed stokers. The average yearly boiler efficiency of these combined plants did not exceed 65 per cent, owing to the comparatively inefficient boiler installations and the heavy fluctuating steam demand. Fig. 1 shows the total steam production by the old plant and also the pressure maintained on the 80-lb. steam main which supplied the whole refinery. With the type of stokers used, it was impossible to maintain a steady steam pressure, and it is obvious that production was bound to be affected by such extreme variations. It is also apparent that even

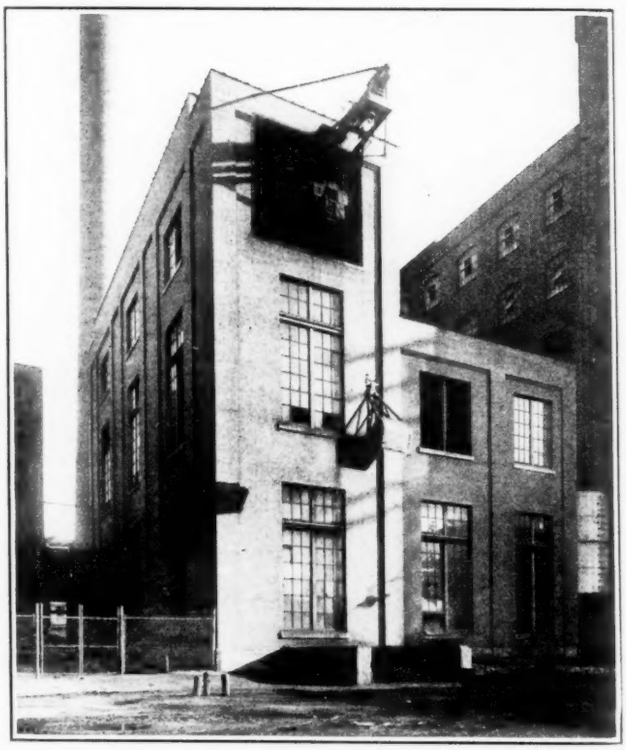


Fig. 2—Outside view of boiler house showing raw coal handling equipment

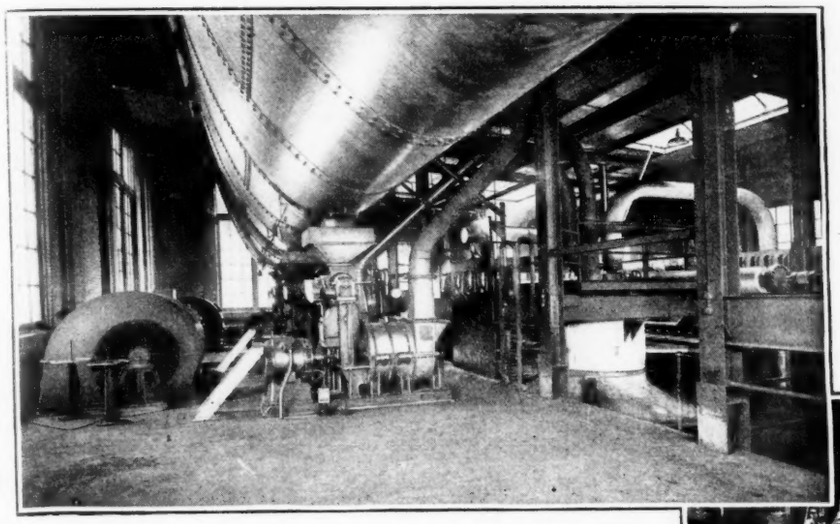


Fig. 3 (Left)—Each boiler is fired by two unit-type pulverizers supplying one burner located central in the top of the circular combustion chamber

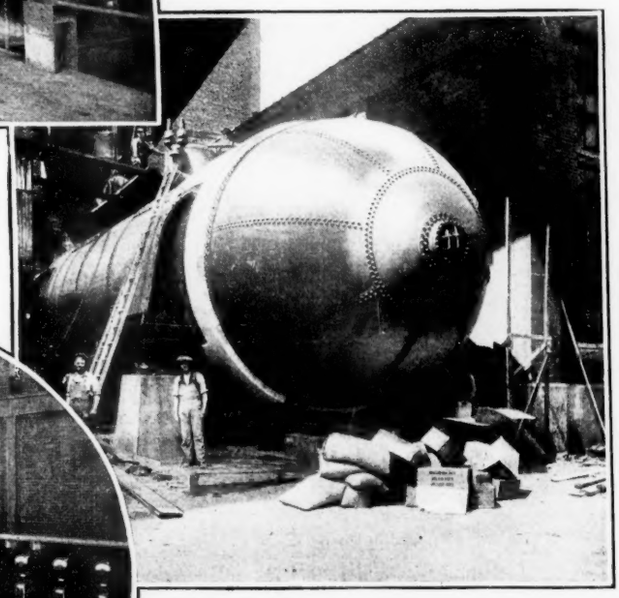
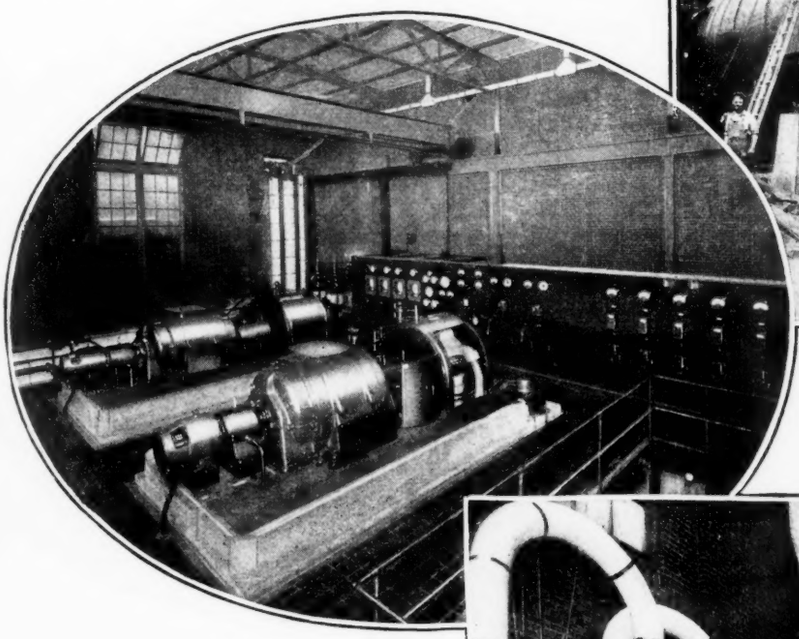


Fig. 5 (Above)—Accumulator of 36,000 lb. per hour capacity located alongside the turbine room

Fig. 4 (Below)—View of turbine room showing the two 1,000-kw. high back-pressure turbine units



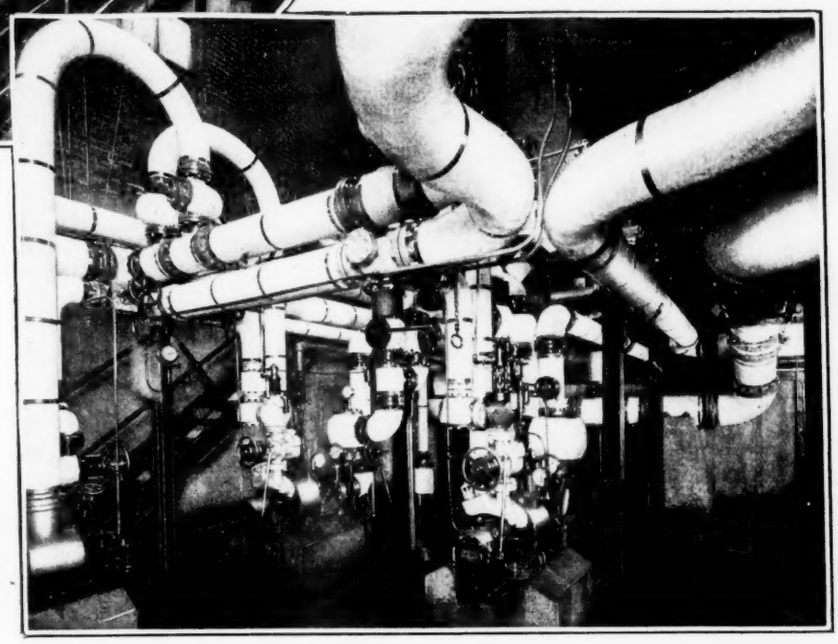
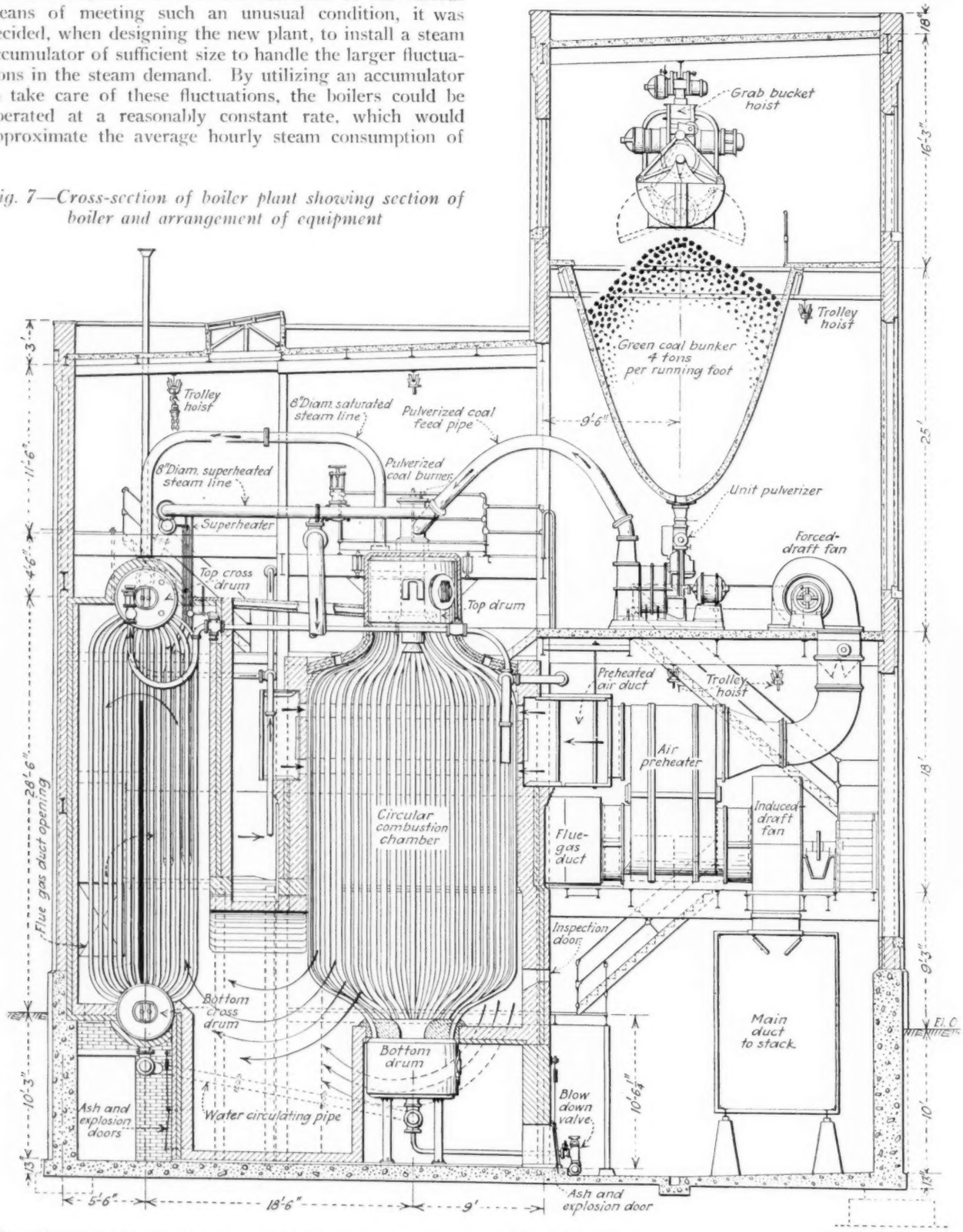


Fig. 6 (Right)—The boilers are served by two single-stage high-speed turbine-driven feed pumps located at one end of turbine-room basement

with flexible steam producing equipment it would be difficult to maintain good boiler efficiency.

Therefore, after careful consideration of the various means of meeting such an unusual condition, it was decided, when designing the new plant, to install a steam accumulator of sufficient size to handle the larger fluctuations in the steam demand. By utilizing an accumulator to take care of these fluctuations, the boilers could be operated at a reasonably constant rate, which would approximate the average hourly steam consumption of

Fig. 7—Cross-section of boiler plant showing section of boiler and arrangement of equipment



the refinery, and therefore they could be expected to operate at maximum efficiency at all times. Furthermore, the cost of the complete accumulator installation would be less than half the cost of an extra boiler with its auxiliaries to handle the fluctuations in load, and then it is doubtful if constant steam pressure could be maintained.

Up to this time the larger part of the required power was purchased hydro-electric, a small amount, chiefly for

pumping purposes and belt-driven centrifugals, being generated in a few reciprocating engines exhausting into the 15-lb. steam line. The hydro power received at 12,000 volts was stepped down to 2,200 volts to drive motor-generator sets which delivered 110- and 220-volt power to the plant. The motor-generator sets were in a separate power house about midway between the boiler plants.

As much of the equipment in the refinery was belt-driven from lineshafting, which was not conducive to cleanliness and was expensive in upkeep, and as the motors in use were showing signs of weakness, due to hard service, it was considered advisable to replace practically all this equipment with direct-connected motors, totally inclosed and pipe-ventilated. It was also considered that a material saving could be made in the cost of power by installing high-pressure boilers and using part of this steam to generate the necessary power and then use the exhaust at the same pressure as was supposed to be maintained by the old boilers.

Owing to space limitations on the plant site, it was necessary that the entire new plant be erected on the site formerly occupied by the Lancashire boilers. It was also necessary that the entire work be carried on without delaying or interfering in any way with the operation of the refinery. The first step of the work was that of removing a sufficient number of the old boilers to provide space for one new boiler. This work was begun Aug. 15, 1925, and the new unit was placed in operation Feb. 20, 1926.

Modern Plant Replaces Two Old Boiler Houses and Separate Power House

In designing the new plant, provision was made for replacing the two old boiler houses and power house with a single power plant consisting of a boiler room to contain three modern high-pressure boilers to use pulverized coal, and a turbine room to contain three modern high back-pressure turbines. Provision was also made to install a large capacity steam accumulator, as previously mentioned, to handle the large and frequent fluctuations in the steam demand of the refinery.

So far, only two boilers and two turbines with the accumulator have been installed and put into successful operation, as these have been found ample to fulfill the present requirements of steam and power for the whole refinery.

The decision to use pulverized coal as the method of firing the boilers was reached after a prolonged study of plants using this method. It was also influenced by the fact that it would make possible the satisfactory use of the Nova Scotia coal, with which considerable trouble had been experienced in using other methods of firing in the old plant.

The boilers installed at this plant are of special interest. They were designed primarily for pulverized-coal firing by Charles W. Burroughs, who was then chief plant engineer of the refinery.

Each boiler has a water heating surface of 7,656 sq.ft. and is designed to generate steam at 300 lb. pressure and 70 deg. F. superheat, and to operate continuously in excess of 300 per cent of rating.

For some time before this unique boiler was put in operation, much adverse criticism was expressed by a number of authorities on boiler and furnace design. However, the original unit has been in satisfactory operation for the last eighteen months and the second unit, exactly similar to the first one, has been operating continuously for eight months without the least sign of trouble of any kind.

Referring to the cross-section of the plant Fig. 7, it will be seen that the boiler is of extremely simple construction, consisting of only four plain drums into which are expanded plain boiler tubes of comparatively few shapes. The boiler is built in two sections; one consists of a combustion chamber, and the other is an economizer section. The upper drums of the two sections are connected by ten 4-in. boiler tubes and one 8-in. steam pipe, while the lower drums are connected by two 8-in.

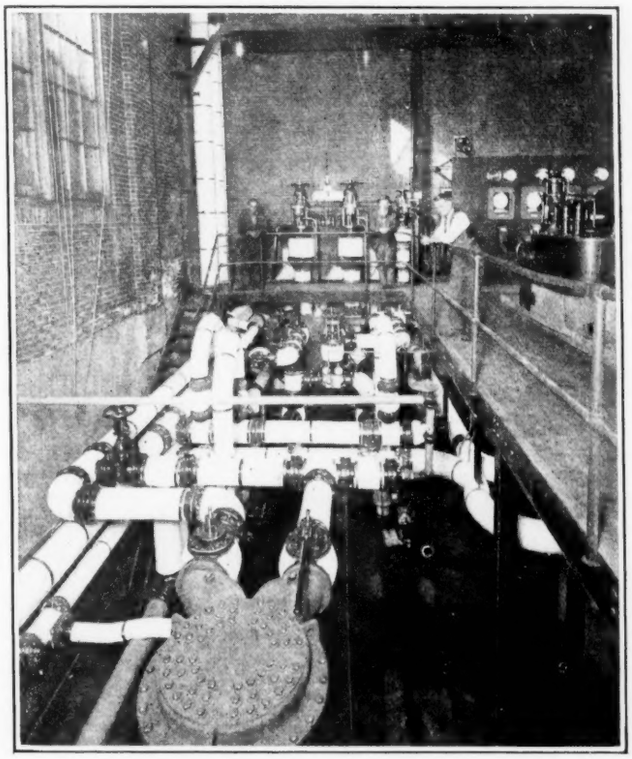


Fig. 8—Shows neat and compact arrangement of feed-water heater and piping as viewed from turbine-room floor. Note oil-operated regulating valves in background

water circulating pipes as shown. This design gives an extremely rapid and positive ring-flow circulation.

In the combustion chamber section of the boiler, the tubes completely surround the furnace in "birdcage" fashion, the whole being inclosed in a refractory casing. By this arrangement the backs of the tubes receive the reflected heat from the circular furnace wall, and this refractory wall is maintained in a relatively cool condition. Full advantage is also taken of flame radiation.

The pulverized coal supplied by two unit-type pulverizers per boiler, is introduced into the furnace through a single turbulent-type burner designed by Mr. Burroughs which passes through an opening in the center of the top drum of the combustion chamber. With this central location all the tubes are subjected to like condition. A similar opening in the bottom drum provides accessibility to the interior of the furnace for cleaning, etc. The secondary air required for combustion, after passing through the preheater, is introduced tangentially

to the circular wall of the combustion chamber through controllable nozzles at two different levels in the preheated air duct which completely surrounds the combustion chamber. As the preheated air is introduced at high velocity through these nozzles and in opposite directions for the two levels, a violent turbulence is set up within the furnace.

The separate economizer section, which forms an important part of the circulating system of the boiler, also contains the superheater, which is interposed between the boiler tubes in the first pass of this section.

The steam generated in the combustion chamber mixes with the steam liberated in the economizer section and passes out through a horizontal dry pipe in the top drum of the economizer section to the superheater header, and after being superheated approximately 70 deg., passes out to the main boiler room header.

Boilers Operate Normally at High Ratings

The two boilers installed have operated for long periods at ratings of 350 per cent of normal and have shown over-all efficiencies above 80 per cent. They are however, capable of operating at a much higher rating if necessary; in fact, they have operated on many occasions for several hours at 400 per cent of rating without any apparent trouble.

The layout of the pulverizers, forced- and induced-draft fans and the air preheater presents a compact and neat arrangement, as will be apparent from the cross-section Fig. 7. As already pointed out, each boiler is served by two unit-type pulverizers. The undried slack coal flows directly from the suspended steel bunker into the pulverizer hoppers. The coal feed to each mill is regulated by a variable-speed d.c. motor, controlled through a hand-operated rheostat. It will be noted from Fig. 7 that the pulverized coal transport pipes, one from each mill, come together in the body of the burner. With this special burner it is possible to run either mill separately or both together, without the use of gates or valves of any description.

Each boiler is equipped with one forced- and one induced-draft fan as will be seen from the cross-sectional elevation of the boiler room Fig. 7, the forced-draft fan being on the operating floor and the induced-draft fan on the floor below. The forced-draft fan discharges through the top half of the air preheater and maintains a pressure of 4-in. static within the preheated-air duct. The induced-draft fan draws the gases through the lower half of the preheater and discharges down to the main breeching running to the chimney. By proper manipulation of the dampers located close to these fans, a balanced draft condition is maintained within the combustion chamber.

The air preheater, which is of the revolving type, is placed with its axis horizontal to simplify the installation and materially lessen the duct work required. This particular preheater was built specially to comply with the specifications of the Canada Sugar Refining Company's designing engineer.

The economizer section of each boiler is equipped with four soot-blower elements, two in each pass, but it has been necessary to use these only once or twice a week, as there is practically no accumulation of soot or ash on these tubes.

There is a well-equipped control panel for each boiler on the operating floor, located in the front of the boiler and midway between its two pulverizers. In addition to a full complement of recording and indicating instruments, on this panel are located all the push-button stations for controlling all motors driving the pulverizers, fans, etc. Furthermore, there is an inspection port in the lower portion of this panel, whereby the operator can see at all times the condition of the fire within the combustion chamber. Thus, the operator from a central point has complete information concerning the whole unit.

The coal handling in this plant is done in an exceptionally simple manner. Referring to Fig. 2, it will be seen that a monorail hoist fitted with a one-ton grab-bucket takes the coal from a platform at ground level on which 5-ton motor trucks dump their loads. On passing in over the bunker, a track scale with indicating dial shows the operator the amount contained in the bucket, which he records on a special report form.

As the ashpits of the boilers have large capacity, it is necessary to clean them out only once a week. This is usually done at the week-ends, and two men from the yard department assist the boiler-house crew of two men on duty at this time. The ashes are raked out through the clean-out doors and then shoveled to a steam-jet ash conveyor, which discharges into a large tank outside the building.

Referring to Fig. 4, will be seen the two high back-pressure turbines, each capable of developing 1,000 kw. when running at 3,750 r.p.m. taking steam at 300 lb. 70 deg. F. superheat, and exhausting against a pressure of 80 lb. These turbines were built in Holland and are the latest design of the Erste-Brunner type. This type of turbine was described in *Power*, Sept. 23, 1924. Under test they fulfilled the maker's guarantee of delivering at full load 1 kw.-hr. for 48 lb. of steam consumed under the conditions just mentioned.

These turbines are direct-connected to 550-volt alternators which have a closed system of air cooling. The exciters are on the alternator shaft extension, and so far no commutation trouble has been experienced.

The two turbines are run in parallel for the purpose of increasing the steam consumption as much as possible so that the steam passing from these machines, which has a low degree of superheat, will help in reducing the superheat in the total steam passing to the refinery.

Feed Pumps Are Single-Stage High-Speed Units

In the turbine-room basement are two boiler feed pumps, one being for spare, each having a capacity of 200,000 lb. of water per hour against 360 lb. head. These pumps, which are single-stage, are direct-connected to steam turbines running normally at 7,200 r.p.m. They take the feed water at 180 deg. F. and discharge it through a closed heater, which uses 15 lb. steam to raise the temperature of the water passing to the boilers up to 235 deg. F. There are also two pumps here, of the same design, for handling process water to the refinery.

The reader should observe closely Figs. 6 and 8, to get a proper idea of the compact arrangement of this pumping equipment, together with the connecting piping. It will be noted that lubricated plug-cocks have been used instead of the regular outside screw and yoke gate or globe valves in both steam and water piping. It will also be seen that the turbine room operator has a clear view of all this equipment from the main operating floor.

Referring again to Fig. 4, we see the main switchboard, which is composed of steel sections throughout. At the

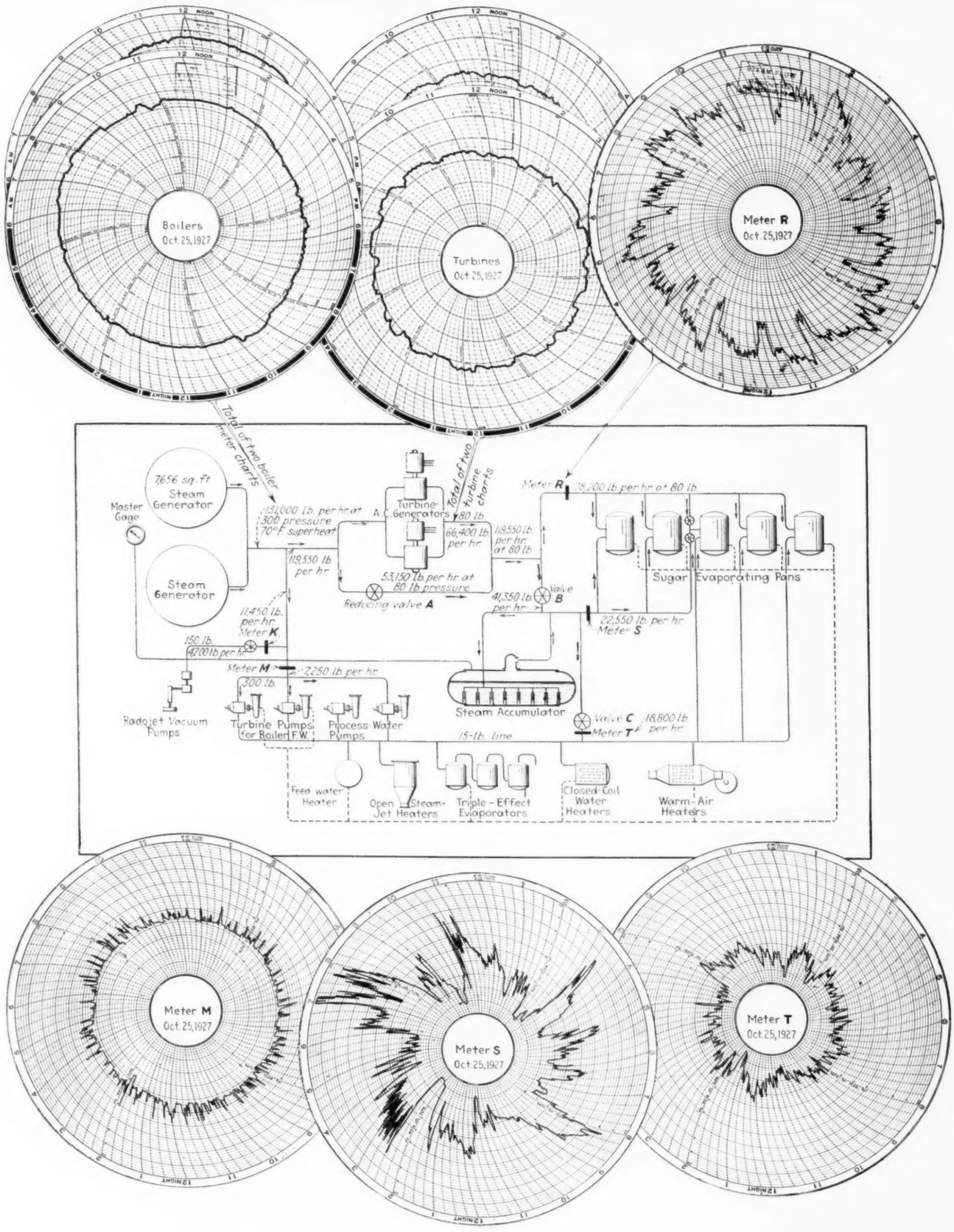


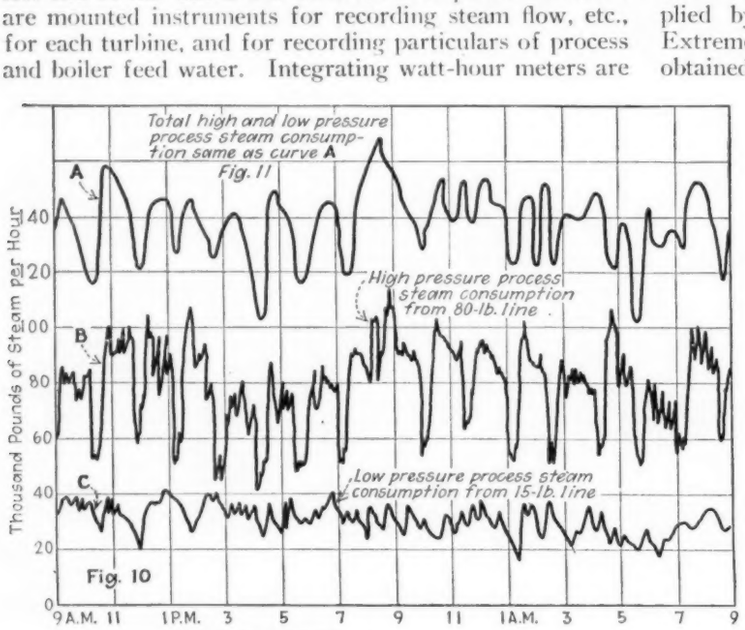
Fig. 9—Schematic diagram of steam distribution, through turbine and reducing valve to process, and to and from accumulator. Also group of steam-flow meter charts for Oct. 25, 1927

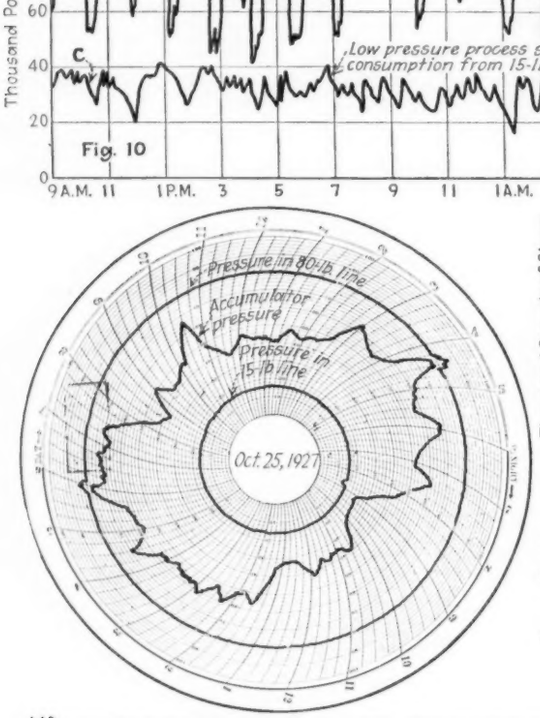
left end of this board will be noted four panels on which are mounted instruments for recording steam flow, etc., for each turbine, and for recording particulars of process and boiler feed water. Integrating watt-hour meters are also installed to record the amount of power used in the various departments of the refinery.

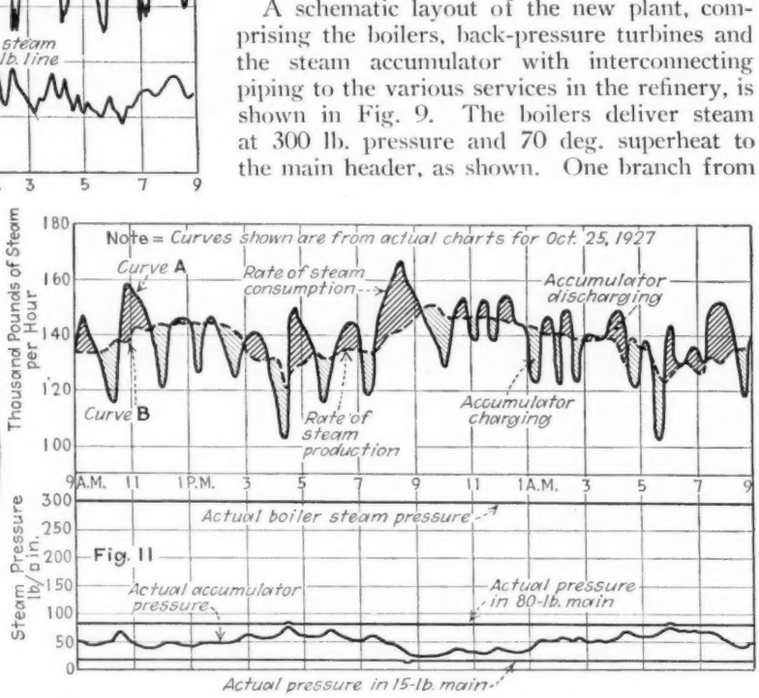
At the extreme left of Fig. 8, will be seen the control valves that constitute the steam switchboard controlling the accumulator, and overflow from main steam header, etc. These control valves are operated automatically by means of diaphragms controlling oil under pressure supplied by a motor-driven oil pump in the basement. Extremely close regulation of the pressure is being obtained by the valves, as is apparent from Fig. 11. In the event of failure of the oil pressure these valves can be manually operated.

The accumulator, which is 55 ft. long by 16 ft. diameter, has a volume of 10,000 cu.ft. and is located alongside the turbine room. In normal operation it contains approximately 9,000 cu.ft. of water, and therefore can store or deliver roughly 36,000 lb. of steam between the pressure limits of 80 and 15 lb. per sq.in. A nozzle in the discharge line limits the rate of steam flow from the accumulator to 40,000 lb. per hour. An idea of the size of this accumulator can be had by referring to Fig. 5.

A schematic layout of the new plant, comprising the boilers, back-pressure turbines and the steam accumulator with interconnecting piping to the various services in the refinery, is shown in Fig. 9. The boilers deliver steam at 300 lb. pressure and 70 deg. superheat to the main header, as shown. One branch from this header supplies 300-lb. steam to the boiler-feed and process-water pumps, while the exhaust from the turbines driving these pumps, goes to the 15-lb. header. Another branch is fitted with a regulating valve which reduces the steam pressure from 300 to 150 lb. on its way to the Radojet vacuum pumps serving the sugar-


Total high and low pressure process steam consumption same as curve A
Fig. 11
A
B
C
High pressure process steam consumption from 80-lb. line
Low pressure process steam consumption from 15-lb. line
Thousand Pounds of Steam per Hour
Fig. 10
9 A.M. 11 1 P.M. 3 5 7 9 11 1 A.M. 3 5 7 9




Note = Curves shown are from actual charts for Oct. 25, 1927
Curve A
Rate of steam consumption
Accumulator discharging
Curve B
Rate of steam production
Accumulator charging
Thousand Pounds of Steam per Hour
Actual boiler steam pressure
Fig. 11
Actual accumulator pressure
Actual pressure in 80-lb. main
Steam Pressure lb./sq.in.
Actual pressure in 15-lb. main
9 A.M. 11 1 P.M. 3 5 7 9 11 1 A.M. 3 5 7 9

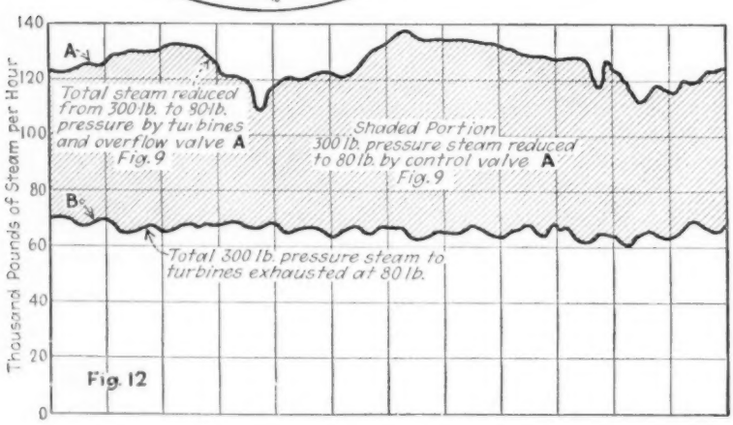

A
Total steam reduced from 300 lb. to 80 lb. pressure by turbines and overflow valve A Fig. 9
Shaded Portion 300 lb. pressure steam reduced to 80 lb. by control valve A Fig. 9
B
Total 300 lb. pressure steam to turbines exhausted at 80 lb.
Thousand Pounds of Steam per Hour
Fig. 12

Fig. 10—Plotted curves of steam consumption of the 80-lb. line and 15-lb. line

Fig. 11—Plotted curves showing total steam production and demand, also various pressures

Fig. 12—Curves show total steam passed through turbines and through reducing valve A, Fig. 9

pan condensers. Farther along the main header divides into two branches, one going to the two 1,000-kw. turbine-generator sets, and the other to the overflow valve *A*. The surplus steam from the boilers passes through this valve *A* to the 80-lb. steam main, and there joins the exhaust from the turbines to supply the 80-lb. requirements of the refinery.

It will be noted that the piping to the sugar pans is so arranged that all pans can draw directly from the 80-lb. steam if so desired. It is also clear that two of these pans can draw directly from the accumulator if necessary, while two other pans are arranged to draw from all three sources of steam supply. The demand for steam on both the 80-lb. and 15-lb. lines is extremely variable, as is apparent from steam-flow curves *B* and *C* on Fig. 10; therefore, at certain times when the demand in the 80-lb. line decreases, as when a sugar pan is stopped, the pressure in this line tends to rise; when this occurs control valve *B* allows the surplus steam to overflow to the accumulator line.

On an average, a sugar pan "strike" is completed every hour and a half and the use of steam is discontinued for 10 to 12 minutes. When the pan finished it was using 80 lb. steam at the rate of at least 50,000 lb. per hour, so that during this 10-min. interval a surplus would exist and the pressure tend to rise in the 80-lb. main. It is at this time that the control valve *B*, Fig. 9, allows this surplus to pass into the accumulator line.

Referring to Fig. 11, will be seen an actual chart from the instrument recording the pressures in the 80-lb. main, the accumulator and the 15-lb. main. These pressures have also been transferred to a rectilinear chart as shown. Curve *A*, Fig. 11, shows the rate of steam consumption for the whole refinery obtained by adding together the steam flow from a number of meters as shown on Fig. 9. Curve *B* shows the rate of steam production. It is clearly shown by means of the shaded portions between these two curves the periods when surplus steam is being absorbed by the accumulator and when the accumulator is discharging to the 15-lb. line. Fig. 12 is of interest simply in showing the steam consumption of the turbines and the amount of high-pressure steam reduced to 80 lb. by the valve *A*, Fig. 9.

It has been shown that the steam consumption of the two turbines amounts to approximately 66,000 lb. per hour when developing a load of 1,100 kw. By referring to the steam tables, we find that there are 1,252 B.t.u. per pound of steam entering the turbines and that there are 1,188 B.t.u. in every pound of exhaust. Therefore, only 64 B.t.u. per lb., or slightly over 5 per cent of the heat in the steam supplied to the turbines, has been extracted. Furthermore, as the steam used by the turbines is about one-half of the total steam generated by the boilers, it follows that only $2\frac{1}{2}$ per cent of all the steam used is required to produce the power for the refinery.

In considering all costs related to the production of power it is found that they are today just one-quarter of what they were before the new plant was put into operation.

Acknowledgment is made to C. W. Burroughs, plant manager of the Canada Sugar Refining Company and A. L. Morgan, chief engineer of power plants, and to their assistants for co-operation in making available the information contained in this article.

MECHANICAL EQUIPMENT IN POWER PLANT OF CANADA SUGAR REFINING COMPANY, LIMITED

BOILERS AND AUXILIARIES

Boiler manufacturer	John Inglis Co., Ltd.
Type (Burroughs)	4 drum, 2 section
Number installed	2
Heating surface, sq.ft.	7,656
Furnace volume, cu.ft.	3,828
Ratio furnace volume to heating surface	0.5
Operating pressure, lb. gage	300
Superheat, deg. F.	70
Superheater (Elesco)	Superheater Co.
Heating surface, sq ft.	602
Air heaters (Ljunstrom)	Air Preheater Corp.
Average temp. inlet air, deg. F.	80
Average temp. outlet air, deg. F.	520
Soot blowers	Vulcan Soot Cleaner Co.
Feed water regulators (Copes)	Northern Equipment Co.
Pop safety valves	Crane Co.
Blowdown valves	Yarnall-Waring Co.
Stop and check valves	J. Hopkinson & Co., Ltd.
Fuel, bituminous coal	13,690 B.t.u. per lb. dry

STACK AND DRAFT EQUIPMENT

Stack (1 for 3 boilers)	Radial brick
Diameter, ft.	14 ft. at base, 10 ft. at top
Height above burners, ft.	200
Induced-draft fan	1 per boiler,—Sheldon Co., Ltd.
Capacity each, cu.ft. per min. at 3-in. s.p.	46,000
Drive	50 hp. motor
Forced-draft fan	1 per boiler,—Sheldon Co., Ltd.
Capacity cu.ft. per min. at 4.1-in. s.p.	30,000
Drive	40-hp. motor

COAL HANDLING, PULVERIZING AND BURNING EQUIPMENT

Raw coal hoist	Shepard Elec. Crane & Hoist Co.
Raw coal bunker	Suspended steel
Capacity	4 tons per lineal foot
Pulverizers	Simplex, two per boiler, built by Peacock Bros., Montreal, for Furnace Engineering Co.
Capacity each, lb. per hour	4,500
Drive	50-hp. motor
Burners, type and number	Burroughs, one per boiler

GENERATING UNITS

Manufacturer	Stork Bros.
Number installed	2
Turbine, type	10 stage, Erste-Brunner
Steam conditions	Inlet pressure, lb. gage 300 Superheat, deg. F. 70 Exhaust pressure, lb. gage 80
Generator manufacturer	Lancashire Dynamo & Motor Co.
Size and type	1,000 kw., 550 v., 62½ cy.
Generator air cooler (closed type)	Heenan & Froude Co.

FEED PUMPS

Manufacturer	G. & J. Weir
Number installed	2
Type —centrifugal, single-stage	7,200 r.p.m.
Head, lb. gage	360
Drive	Weir, single-stage steam turbines

ACCUMULATOR

Manufacturer	Canadian Vickers, Ltd.
Type	Ruths
Capacity, lb. per hr.	40,000
Operating condition, lb. gage	80 to 15
Insulation	Sil-o-cel brick with canvas cover and Celcote.

MISCELLANEOUS EQUIPMENT

Switchboard	Ferguson-Paulin Co.
Turbine-room crane (20-tons cap.)	Morris Crane Co.
Temperature recorders	Bailey Meter Co.
Pressure recorders	Bailey Meter Co. Foxboro Co. American Schaeffer-Budenberg Co.
Steam meters and draft gages	Bailey Meter Co.
Pressure gages	Foxboro Co.
High-pressure valves	J. Hopkinson & Co., Ltd.
Low-pressure valves	Walworth Co.
Steam piping	M. W. Kellogg Co.
Pipe covering (85 per cent magnesia)	Canadian Asbestos Co. Jamejson Co.
Expansion joints	E. B. Badger & Son Co.
Plug cocks	Merco-Nordstrom Valve Co.
Feed-water heater (closed type)	G. & J. Weir
Track scale	Toledo Scale Co.
Regulating valves (accumulator)	Ruths Accumulator Co.
All motors	Lancashire Dynamo and Motor Co.

Utilization of Waste Heat in the CEMENT INDUSTRY

By C. G. SPENCER

Under normal conditions the energy available in the waste gases is sufficient through the use of waste-heat boilers, to operate the plant and in many cases is in excess of the plant requirements

THE margin of profit today in the cement industry is so small and competition is so keen that mill costs must be reduced if the industry is to prosper. Mill costs, aside from raw materials, are made up of three major items—fuel for kilns, power and labor. The relative amounts of these three depend on local conditions and plant design. In the majority of cases the cost of fuel for kilns, usually coal, is the largest single item, being from 25 to 35 per cent of the mill cost, including raw material. The cost of power depends on the source whether from independently fired boilers, purchase, waste-heat boilers or a combination of these. Labor cost is influenced by the number and size of the units in the several departments of the mill. The trend in modernizing old plants and in the design of new plants is toward a smaller number of large units.

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The heat in the waste gases, where these gases are allowed to escape at a high temperature to atmosphere on leaving the kiln, offers the greatest opportunity for saving by the use of waste-heat boilers and the generation of electrical energy. It is dangerous to generalize on the extent of this saving, but in order to give a picture, it may be stated that for average conditions the potential capacity in kilowatts is equal to the daily kiln capacity in barrels. That is, a 1,500-kw. load can be carried by the utilization of the heat in the gases from a kiln having a capacity of 1,500 bbl. of clinker a day. Stated another way, there is available 24 kw.-hr. for each barrel of clinker burned. The power requirement for a completely electrified cement plant varies from 15 to 25 kw.-hr. per barrel of clinker.

When the power generated by waste heat supplies the demand of the mill, the second large item of mill costs is reduced to the fixed charges plus the operating expense of the waste-heat plant, the difference between this and the previous power cost being available for increased earnings.

Where power is a large item of mill cost, careful supervision is exercised to hold it at a minimum. With excess power, at no additional expense, the operator can grind finer and introduce other power consuming refinements which produce a better product.

The output of a waste-heat boiler is dependent on the weight and temperature of the gases available. Both of these factors are influenced by the method employed in manufacture, that is, whether the raw material is ground dry or wet. At the present time in the United States and Canada, the industry is about evenly divided, there being 81 dry and 86 wet process plants either operating or under construction, the tendency being toward the use of the wet process. The weight of the gases from a dry process kiln, other conditions being the same, is less and the temperature higher. These gases are for the most part carbon dioxide driven off the limestone in the raw mix and the products of combustion of the fuel used. In the wet process, where the wet mixture, or slurry, is fed directly to the kiln, additional coal, in the order of 25 per cent, is required and the temperature of the gases is reduced by the evaporation of this water. The gases in this case, in addition to the carbon dioxide from the limestone and the increased quantity of products of combustion from the coal, contain the water evaporated from the slurry, in the form of superheated steam. The items to be considered in determining the weight of gas are: The analysis of the coal, the pounds of coal per barrel of clinker, the chemical analysis of the raw mix and the percentage of water in the slurry. The temperature of the gas is influenced by the length of the kiln and the radiation losses.

In an average kiln the preventable radiation losses can be reduced from about 8 per cent of the coal burned to

about 2 per cent, or a saving of 6 per cent. It is not feasible to insulate at the burning zone, but the saving is usually sufficient to warrant the use of insulating material from a point just beyond the burning zone, to the feed end of the kiln or to a point where the temperature of the gas and the losses no longer warrant the expense. The early experiences of insulating kilns were not satisfactory largely because of the failure of the material to stand up mechanically. Improvements in material and methods of application have largely overcome previous troubles so that today the preventable radiation losses can largely be eliminated.

This discussion has had to do so far with the gases up to the point where they leave the kiln. Between the kiln and the boiler care must be exercised to prevent air infiltration which results in an increase in gas volume through the boiler and a reduction in gas temperature.

A waste-heat boiler must be designed for a large volume of low-temperature gas, and because of the dust in the gases, it must be arranged for easy cleaning and disposition of the dust collected. A waste-heat boiler seldom operates above 75 per cent of builder's rating, for which reason the maintenance expense is low. Economizers are essential for maximum heat utilization.

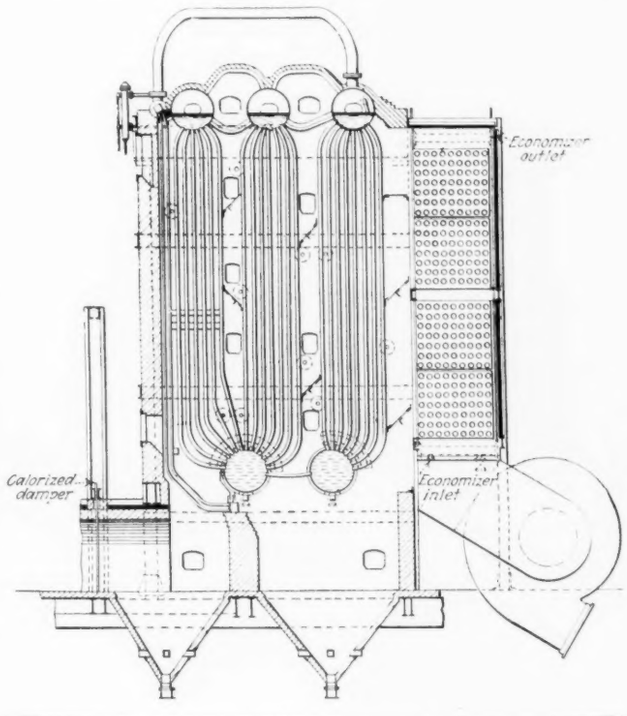
Performance of Prime Mover Affects Sufficiency of Waste-Heat Power

Most cement plants are located at a distance from an adequate supply of condensing water which necessitates the use of a cooling tower or spray pond with resultant higher over-all water rate of prime movers. In mills where steam-electric plants are operating with inefficient turbines or reciprocating engines, waste-heat boilers are often installed to supply the steam previously produced in separately fired boilers. The result is that the amount of power generated by the waste-heat installation may be below expectation. The two factors of insufficient circulating water and the high water rate of the existing prime movers account in many cases for a shortage in power from waste heat. A study of the figures available from a large number of waste-heat installations, shows results varying from 15 to 35 lb. of water per kilowatt-hour. Obviously, a plant operating on a 15-lb. water rate will generate more than twice the energy for the same amount of steam that a plant operating on a 35-lb. water rate will generate. While this is an obvious conclusion, it is not uncommon to compare waste-heat boiler performance on the ability of the plant to supply the mill demand for power and to overlook the performance of the prime movers.

Because of this and the zeal on the part of engineers to have enough power from waste heat to operate the mill, there is a tendency toward unwarranted expenditures to produce low water rate operation. Experience and judgment, equal to that applied on the design of a central station, is required for the proper evaluating of the various factors and in the making of the major decisions for a waste-heat steam-electric plant.

Power generated from the heat in waste gases is directly dependent on kiln operation and fluctuates with changes in production. In a plant having a large number of kilns, this is not a serious problem; but in a modern plant, with a small number of large kilns, provision must be made for a secondary supply of power to carry on essential operations independently of kiln production. This is usually done by the installation of a separately fired boiler or by means of an outside power connection. The latter is not attractive from the power company's point of view, with the result that the charges are excessive as compared with those for supplying the whole or a large part of the demand. In some favorable locations a reciprocal arrangement for the exchange of power can be worked out with the power company.

Where there is no outside connection the separately fired boiler is essential not only for starting up, but for supplying deficiencies during periods of kiln shutdowns or curtailed kiln production. An interesting point and one that is not usually understood is the relative cost of producing additional steam in a waste-heat boiler and in a separately fired boiler. The natural procedure, where waste-heat boilers have been installed, is to increase the amount of coal burned in the kiln beyond that required for the kiln operation and to generate the additional

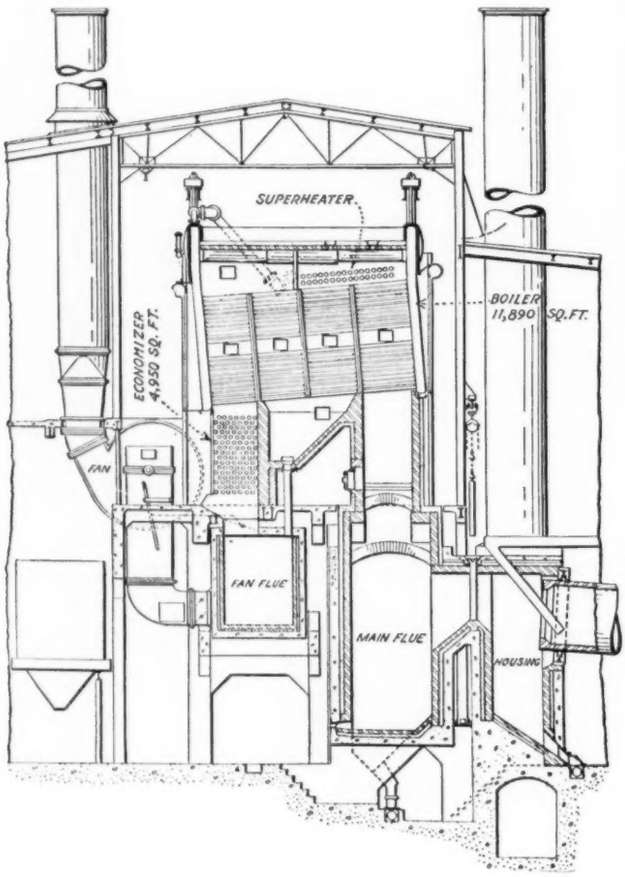


Vertical Type Waste-Heat Boiler

steam in the waste-heat boiler. Within reasonable limits and for short periods this practice is sound because the waste-heat boiler is equipped with an economizer which reduces the exit gas temperature to 400 deg. or less and the separately fired boiler, so far as the writer's experience goes, is never equipped with an economizer.

The additional coal burned in the kiln increases the exit gas temperature and, if carried to excess, forms slag on the boiler tubes which can be removed only by shutting down the boiler. A part of the heat liberated in the kiln by burning the excess coal goes to raise the temperature of the whole gas mass in the kiln. Even though the exit gas temperature from the economizer is low as compared with that from a separately fired boiler, it is higher when excess coal is burned in the kiln than under normal operation and because of the large amount of gas leaving the economizer there is an increased loss of heat in the exit

gases. The increased volume also increases the velocity of the gas through the boiler and economizer. Since the resistance to flow and hence the power required to drive the induced-draft fan increases as the square of the velocity, this larger gas volume consumes a greater percentage of the excess power generated. A pound of coal burned in a kiln in excess of kiln requirements generates steam in the waste-heat boiler at about 65 per cent efficiency. A pound of coal burned in a separately fired boiler under normal conditions generates steam at about 70 per cent efficiency. If the requirement for extra steam is of an



Typical Waste-Heat Setting for Horizontal water-tube boiler

appreciable amount, say 10 lb. of coal or more per barrel of clinker and is for an extended time, it is economical to operate a separately fired unit.

At this point it would be desirable to define the limits that determine the purchase or generation of power by waste heat. There are cases where power is purchased so cheaply that waste-heat installations are not economically justified. There are so many local conditions that enter the problem that it is futile to make a general statement as to how cheaply power must be purchased to prohibit a waste-heat installation, but speaking generally there are but few favored localities today where waste-heat plants are not justified.

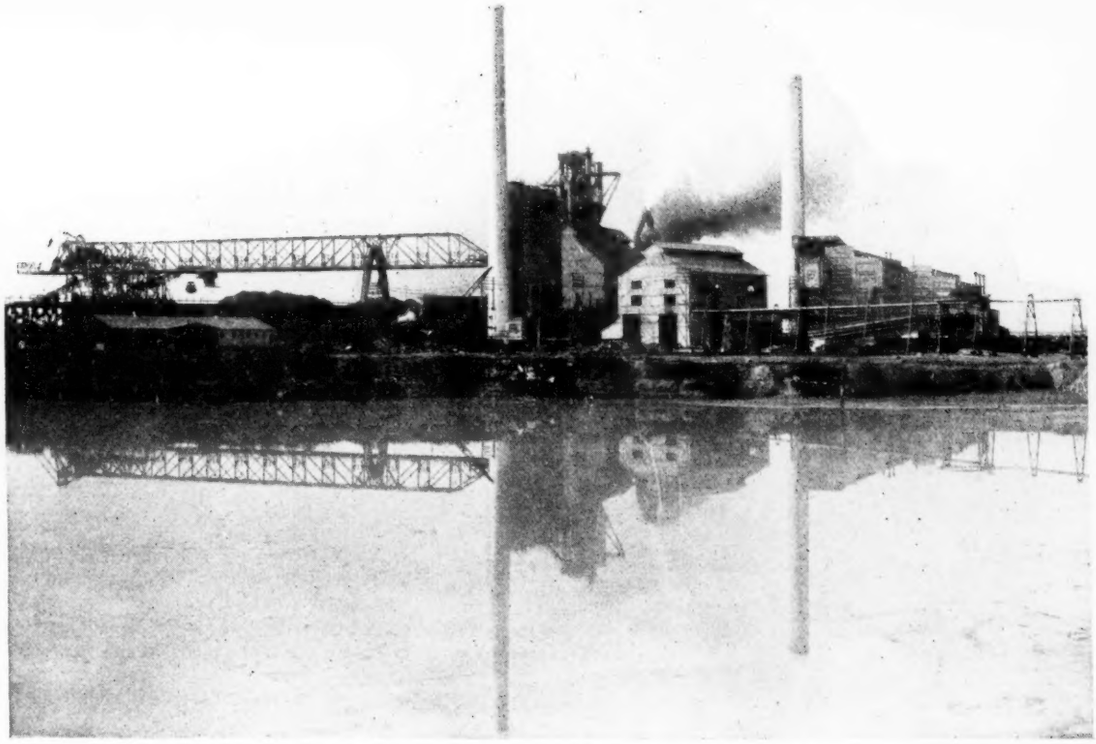
Better heat utilization may be obtained in plants where waste-heat boilers are not warranted by the use of the long kiln. Since this article has to do largely with existing plants where the kiln length is fixed and the capital investment is considerable in rebuilding of kilns, usually because this requires complete rearrangement, this method of effecting savings will only be touched upon.

The spray method of slurry feed also applies to plants where waste-heat boilers are not contemplated. This system was developed in England where there are several plants in operation. The slurry is pumped at a pressure of about 100 lb. into a manifold which supplies nozzles, at from 45 to 80 lb. pressure. These deliver the slurry to the kiln in a finely divided spray. This exposes a large surface to the gases and effects a reduction of from 20 per cent to 25 per cent in the coal requirement for equal kiln capacity, with a reduction in exit gas temperature to a point that prohibits the installation of waste-heat boilers. The system is now being introduced in this country, and operating results should be available within the next twelve months.

The methods discussed so far of saving fuel in wet process plants have all had to do with more efficient evaporation of the water in the slurry by utilizing heat in the gases. It has been realized for many years that a method that would remove the water from the slurry before it entered the kiln would be even more effective, since it takes, in round numbers, a thousand heat units to evaporate a pound of water and each barrel equivalent of slurry contains about 300 lb. of water. This has led to many attempts to filter the slurry which, in the early days, were not successful. Developments in filter design and a better knowledge of the problem have resulted in machines which are reducing the moisture from 32 or 40 per cent down to an average of 20 per cent or even lower. If a condition is assumed of 600 lb. of raw material per barrel of clinker, a 33 per cent slurry will weigh 900 lb. per barrel equivalent. A 20 per cent slurry will weigh 750 lb. or a difference of 150 lb., which is a 50 per cent reduction in water content. Unlike the other methods referred to of better evaporation at the expense of temperature, this method effects a saving of about 20 per cent in the coal requirement, but in addition tends to increase the temperature of the exit gases, which is more favorable for waste-heat power generation. While modern installations of filters are little more than two years old, results so far are satisfactory and there are at least three types of commercial filters available for this service.

Clinker leaving a kiln is usually at about 2,000 or 2,100 deg. F. The sensible heat in this clinker is ordinarily used to preheat the combustion air, of which about 20 per cent enters the kiln with the coal as primary air and the balance is drawn in as secondary air. This heat can all be used advantageously in preheating the secondary air. Attempts to preheat the primary air with heat recovered from the clinker have usually been unsuccessful, but since the secondary air can readily absorb the total amount, there is no outstanding incentive to divide it. There are several types of commercial coolers that, except for small radiation losses, fully utilize this heat.

In some plants, however, this heat is wasted and, because of the plant layout, coolers to preheat the combustion air are not feasible. The sensible heat above 200 deg. in this clinker, if converted into power, would generate 8 kilowatt-hours for each barrel of daily kiln capacity or about one-third the amount generated by the waste gases. Attention is being given to the utilization of this heat. The advantage extends beyond the heat saved because of the value to the operator of producing cold clinker, which permits of grinding the clinker as produced.



Blast-furnace plant and power station of the Mystic Iron Works, Boston, Mass.

Power Generation *in the* Steel Industry

By Gordon Fox

Electrical Engineer, Freyn Engineering Company, Chicago

THE production of steel involves metallurgical transformation of the raw materials and mechanical configuration of the product. The metallurgical operations primarily embrace the conversion of coal to coke, gas and byproducts, conversion of ore to pig iron, and conversion of iron and scrap to steel. These operations involve the release of large quantities of heat, the utilization of lesser quantities of heat and the incidental use of moderate quantities of power.

In the coke ovens the heat liberated in the production of coke is in the form of coke-oven gas and coke breeze; the heat demanded is for heating the ovens and the power is for coal preparation, conveying and accessory operations. From the blast furnace the heat liberated through reduction of the ore is in the form of blast-furnace gas, the heat demanded is for heating the air blast and the power is primarily for compressing the air blast and, incidentally, for handling materials. Around the steel works the heat liberated is in the form of stack gases which may be utilized in waste-heat boilers for steam production. The heat demand is for melting and refining the steel, and the power is used largely for handling materials.

Rolling mills are large users of both power and heat. Power is used for working and shaping the metal; heat is required to maintain suitable temperature for such working. In some instances waste-heat boilers are used on heating furnaces but, in the main, rolling mills afford little byproduct power.

The heat balance of a steel mill comprising integrated coke ovens, blast furnaces and rolling mills refers to the ratio of heat liberation in coke-oven gas, blast-furnace gas and waste-heat sources, to the heat and power required for processes. This balance is dependent upon many factors, the foremost being:

The character of the coal coked, which affects the quantity and heat value of the gas.

The character of the iron ores, which affect the blast-furnace coke rate.

The disposal of the iron produced, whether sold as iron or delivered to the steel works for conversion to

steel. If a substantial portion of the iron output is sold in that form, a relatively high heat availability accrues to the relatively decreased steel output.

The method of steel manufacture which affects the ratio of pig iron to steel production. Where the bessemer process is used, the iron tonnage is roughly equal to the steel tonnage. When the open-hearth process is used, quantities of scrap are charged and the iron production is about one-third of the steel production.

The degree to which the product is finished or remanufactured, which determines largely the power and heat required for rolling and fabrication.

In order that a general picture of the heat balance in an American type of steel plant may be obtained, Table I has been prepared to show, in an approximate manner, the power requirement and the process-heat requirement of the several major operations. The plant depicted uses exclusively the open-hearth process of steel manufacture with about 40 per cent hot pig iron and 60 per cent scrap.

For comparative purposes, Table II shows the total byproduct heat available to meet the demands shown in Table I.

It will be noted, by comparison of Tables I and II, that under the set-up presented there is a decided deficiency in process heat below plant demands. This condition is generally true in American plants. In some foreign plants, which use the Bessemer process of steel making more extensively, the heat availability balances the heat requirement more closely.

There is a distinct trend in the American steel industry toward the more efficient utilization of heat. This applies mainly to better combustion at all points, more efficient power development and use, and reduction of general losses. Electrification of mills and replacement of steam-operated mechanisms by electric drives have steadily reduced the consumption of steam outside of the central power station. The coke ovens still use steam for the oven exhausters, the low-pressure discharge being used in byproduct processes. Considerable quantities of steam are used for gas producers and for pickling vats, and some plants have a number of steam hammers.

Better heating, faster rolling, more efficient mills and drives and the application of roller bearings are some factors that may tend to reduce power requirements. On the other hand, higher blast heats are lowering blast furnace coke rates and thus decreasing the surplus heat available per ton of iron. As long as present basic processes are used, the general condition of deficient heat balance in American steel works will probably continue.

The shortage in heat availability in American steel works is commonly made up by use of coal in gas producers, by use of coal in heating furnaces, by use of oil and tar, by use of coal under boilers, by purchase of electric power.

The question of fuels and their proper application is of broad scope and beyond the intent of this article. A few general remarks may be enlightening.

Blast-furnace gas is used universally for preheating the furnace air blast. It is excellently adapted for this purpose because of its combustion characteristics, its convenience and the consonance of supply and demand. It is quite extensively used abroad for heating coke ovens. Its long flame and resultant uniform heating characteristics are distinctly advantageous. The fact that the coke-oven use is continuous throughout the week is favorable. It is probable that this application will be extended in American plants. As yet blast-furnace gas is but little used in American steel plants for process heating. Among the factors contributing to this result are: Variability of supply, particularly in single furnace plants; variability as to quality; low heat value and low flame temperature; bulk, affecting cost of transport and preventing extensive storage; variability of heating furnace uses as contrasted with continuous operation of the blast furnace, leaving long periods, as on week-ends, when the blast-furnace gas would not be utilized. Coke-oven gas is used extensively for heating the ovens, about one-third of the gas production being required for this purpose. Ready availability and convenience have been prominent factors determining this practice. This gas is, in general, well adapted for use both in the steel works and in the rolling mills for preheating. In most American plants the coke-oven gas is used for oven heating and for steel-plant uses. To a limited extent this gas is sold to public utilities for general distribution. The week-end make of the ovens is frequently so disposed.

GORDON FOX has for many years been identified with engineering work in the iron and steel industry. His wide experience in designing power systems for iron and steel plants gives him an experience that makes him an authority in this class of work.

The question of fuels and heat balance involves not alone the total byproduct heat production and the total heat requirement; it involves also the synchronization of supply and demand. It is largely because of limitations in the coincidence of supply and demand that byproduct gases are not fully utilized in process heating operations where gaseous fuels are advantageous. This factor applies only in a lesser degree to coke-oven gas, which lends itself better to storage because of its lesser bulk.

The production of steam and power represents advan-

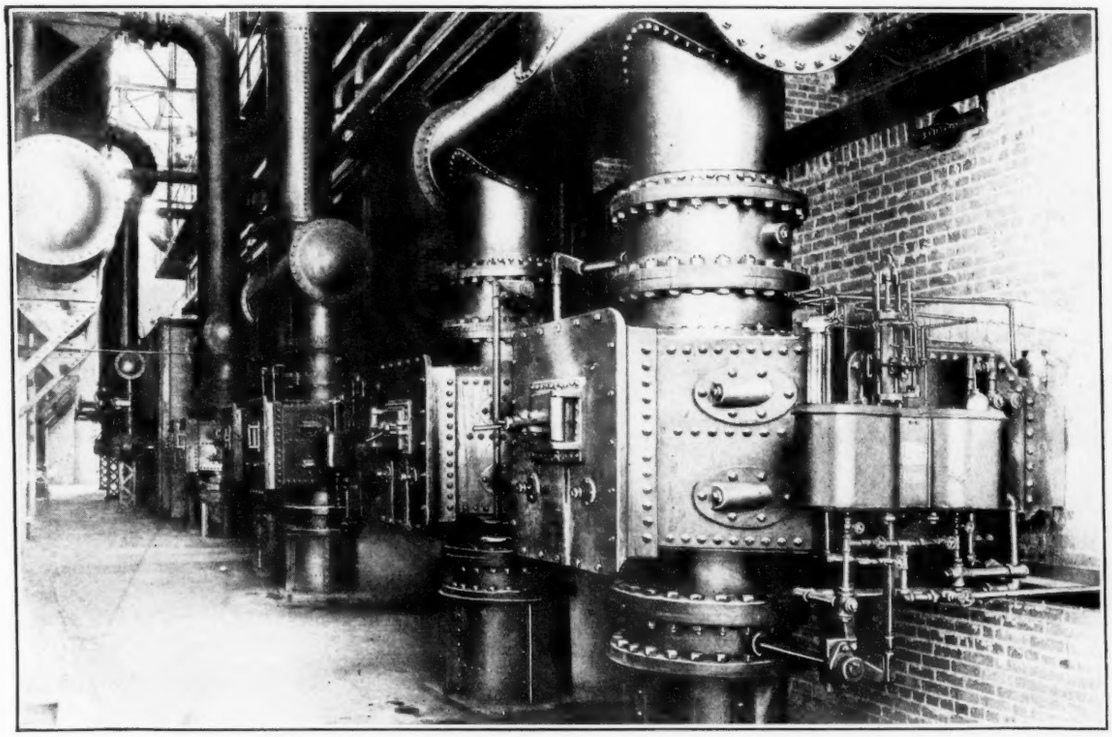
tageous use of blast-furnace gas, because complete utilization is generally possible even if the supply is variable. This condition exists because the electric load ordinarily exceeds the electric production possible from blast-furnace gas. The remainder or excess load can be supplied either by burning supplementary fuels, such as coke breeze and coal, or by purchase of electric power. Thus the electric power system serves as a pool into which may be dumped even the last increment of blast-furnace gas or other surplus byproduct fuel. At any periods of gas deficiency the shortage can be made up by the supplementary fuels. The lack of such flexibility with gas producers and the plant gas system encourages the use of blast-furnace gas under boilers and deters its more general use for heating operations.

In the usual American plant, wherein blast-furnace gas is used only for heating the air blast and for developing power, the amount of power thus developed represents a material part of the total power consumption.

TABLE II—BYPRODUCT AND WASTE HEAT IN IRON AND STEEL MANUFACTURE

	Equivalent B.T.U. per Ton of Ingots
Coke ovens (gas)	3,200,000
Blast furnace (gas)	5,500,000
Coke breeze	600,000
Steel works (waste-heat boilers) (fuel equivalent)	1,800,000
Total byproduct heat	11,100,000

This relation will be seen if there is deducted from the 5,500,000 B.t.u. per ton of ingots available from blast-furnace gas, the amount 1,900,000 B.t.u. per ton ingots required for heating the air blast. The remainder, 3,600,000 B.t.u. per ton ingots, translated into kilowatt-hours at 18,000 B.t.u. kw.-hr. gives 200 kw.-hr. per ton ingots. This is about two-thirds of the total power requirement of the plant.



Rear of boilers, Mystic Iron Works, showing burners for blast-furnace gas

The electric power system in the steel plant can be made an effective pool for byproduct fuel utilization only if there is sufficient load at all times to absorb the power resulting from fuels not feasible of storage, notably from blast-furnace gas. This condition generally exists throughout the working periods, but on week-ends and sometimes during night hours the electric power obtainable from blast-furnace gas may exceed the electric load.

TABLE I—REQUIREMENT OF POWER AND HEAT IN IRON AND STEEL MANUFACTURE

	Power, Kw.-Hr. per Ton of Ingots	Heat, B.T.U. per Ton of Ingots
Coke ovens	3	1,000,000
Blast furnace	52	1,900,000
Steel works	5	6,000,000
Rolling operations	200	4,000,000
Miscellaneous plant services	40	100,000
Total	300	13,000,000
Equivalent of 300 kw.-hr. at 18,000 B.t.u. per kw.-hr.	.....	5,400,000
Total heat requirement	.....	18,400,000

If the coke breeze, 600,000 B.t.u. per ton ingots, be burned under boilers to produce power, an additional amount of 33 kw.-hr. per ton ingots is derived. There still remains 67 kw.-hr. per ton ingots, or 22 per cent of the total power requirement, to be supplied from supplementary fuels or by purchase of power.

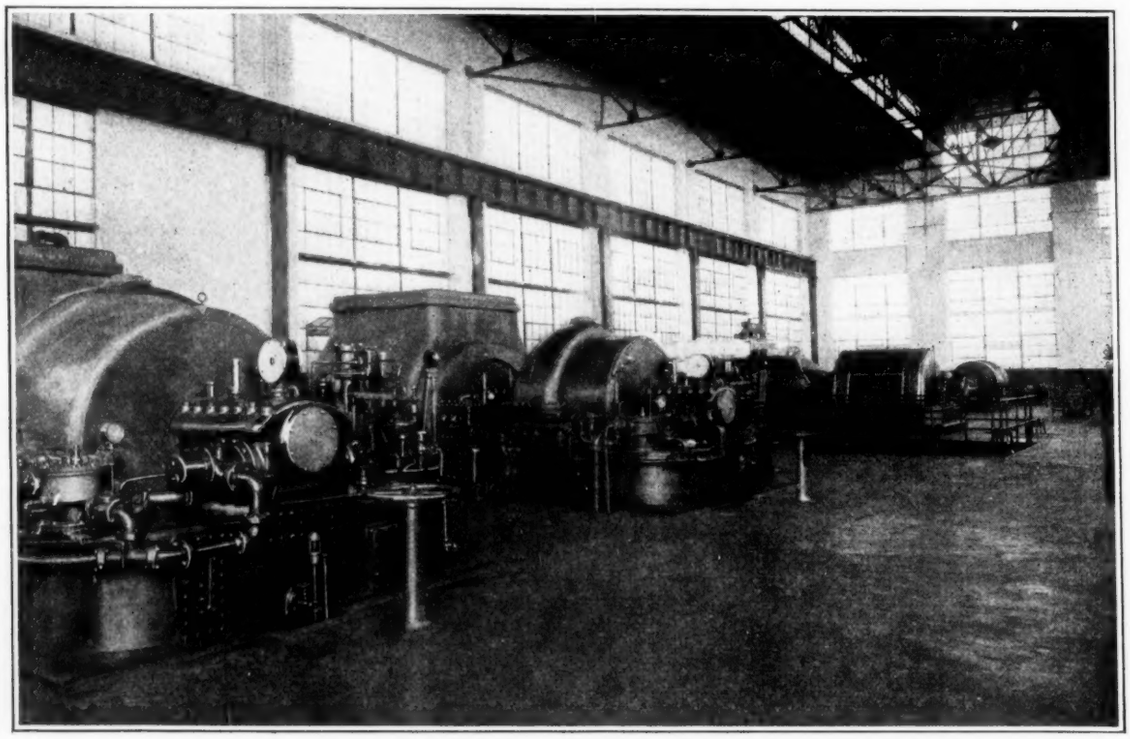
The steam from waste-heat boilers is likely to be used in that form at the coke ovens, gas producers and pickling departments. Thus it goes to make up the heat requirement rather than the power requirement of the plant.

These figures illustrate, in a general way, the relations existing in the typical American steel plant. During weekdays there is a shortage of heat, made up largely by coal firing of heating furnaces and coal used in gas producers, and there is a shortage of power, made up by the firing of supplementary coal under boilers or by the

purchase of supplementary electric power. During week-ends there is likely to be an excess of power.

The amount of power in a steel plant of the size under consideration is such that power generation will be on a large scale. A single-furnace plant having a set-up such as shown in Tables I and II would have a monthly power production, inclusive of furnace blowing, on the order of 8,000,000 kw.-hr., with a weekday average load on the order of an equivalent 12,000 kw., inclusive of furnace blowing. Plants having several blast furnaces would have relatively greater output.

The economy that may be reasonably attained in the steel-mill power plant is slightly less than that feasible in the large central station that has single units of 50,000-kw. capacity and larger. When transmission losses are included, the margin favoring the utility is not great.



Interior of power house, Trumbull Cliffs Furnace Company, Warren, Ohio

Practically every steel plant that includes a blast furnace, includes also a power plant. This is the case not only in order that the furnace gas may be utilized, but also in order that the power for blowing engines or compressors may be developed.

As previously shown, the typical American steel plant develops sufficient power for blowing the furnace and, in addition, much of the plant electrical supply, from the surplus blast-furnace gas. If the steel mill did not require a power plant for furnace blowing and for furnace-gas utilization, it would probably be cheaper to buy electric power than to construct a power plant for its production from coal. If a basic power plant is constructed for furnace blowing and for utilization of blast-furnace gas, then the production of additional power from coal is not an isolated enterprise. The economics of the question is then quite different. The investment in additional equipment necessary for the generation of additional power from coal is less, per kilowatt, than the cost of the initial or basic installation. The operating cost involved in the additional output is small since much of the attendance cost is not materially affected by additional output. The resultant over-all cost, attributable to the additional output from coal, is very low indeed.

A public utility may perform three services for a steel-mill power plant as above situated, namely:

It can supply the electric power required in excess of that which can be developed from byproduct fuels and waste-heat sources, preferably after those fuels have been applied so far as feasible to applications to which they are better suited.

It can provide stand-by protection.

It can serve as a market for electric power available from byproduct-fuels and heat, in excess of plant needs.

In order to function as a supplementary supply of electric power, the utility must compete with the cost of generating additional power and with fixed charges attendant upon the additional plant necessary to that end. A very low rate is necessary to meet these requirements.

Reliability is an essential attribute to steel-mill power. To this end an isolated plant must carry reserve capacity. If the utility system is such that it can provide a stand-by source of power protecting the local plant at a rate comparable with the fixed charges incident to the investment in reserve equipment, such service is attractive. The interconnections accessible to the utility should render such protection possible at a competitive cost, and such service is now being successfully supplied.

The surplus power that the steel mill plant may deliver to the utility, largely during week-ends, is necessarily dump power and must be evaluated as such. Nevertheless, it may prove a material benefit in enabling the complete utilization of byproduct fuels and waste heat, which could not be more effectively used.

Problems in Steam and Power Generation, Distribution and Utilization

In a Modern Rubber Factory

By GARRETT BURGESS
Consulting Power Engineer, United States Rubber Company, Detroit, Mich.

Economy of high-back-pressure turbine compared with that of passing live steam through reducing valve for process

IN THE generation of steam in the rubber industry today, a number of complications are encountered, due to the variety of pressures used. Vulcanizing is generally done at much lower pressures than are required for efficient operation of prime movers and auxiliaries. High steam pressures in central stations having shown excellent economies, has suggested wider application of higher pressures in the industrial field, with high-back-pressure turbines utilized for reductions in pressure.

Generation of steam at high pressures in the boiler room, operating the main prime movers in the power plant at boiler pressure, distributing steam at high pressure and superheat to the different locations throughout the factory and there reducing it through the high-back-pressure turbine at the point of utilization, has proved an economical arrangement.

However, in many instances in the rubber industry it is difficult to use superheated steam in curing. The pressure required at the point of utilization is often not low enough to permit extraction of all the superheat through the turbine. In some instances the superheat may run as high as 70 deg. F. In such cases the steam would have to be desuperheated by other means before entering the curing vessel. Also, the volume of steam required is sometimes so small that a high-back pressure unit is not economical.

VARIATION OF LOAD REQUIREMENTS

The variation of electrical energy required (see Fig. 1) has considerable bearing in high-back-pressure installations. It is generally desirable to tie this unit into the main electrical system, which should have a base load of sufficient capacity to take such fluctuations as the back-pressure unit may deliver into it. In a rubber mill steam demands vary considerably, depending largely upon the schedule of presses and requirements of filling. This, of course, is met constantly by the operation of the governor and the control mechanism of the high-back-pressure units, but it is obvious that the base electrical load must be several times greater than the maximum demand of these turbines. Hence the main system must be designed for at least 80 per cent fluctuation.

Means must be provided for control in case the turbine does not function as quickly as expected, for a slight drop in pressure would cause trouble in the curing process.

The advantage of the high-pressure unit, from an economical point of view, is due to the reduction of steam pressure through the unit to a pressure slightly higher than that required in the vulcanizer, with electrical energy being realized as a byproduct. The piping from the high-back-pressure turbine should have sufficient capacity, so that in the event of several presses being filled at the same time, there will be no drop in steam pressure. A system designed in this way eliminates reducing valves and piping complications, but much depends upon the governor and control mechanism of the turbine. Also, to be assured of a positive pressure and temperature, it is necessary to have means other than the turbine, which is cared for by the desuperheating method.

In order to desuperheat properly, a number of arrangements have been tried out. The success of a desuperheating system depends primarily upon the method of controlling the temperatures rather than on the mechanical features of the desuperheater itself. A system that is working satisfactorily at the present time, and reducing from 200 lb., 150 deg. superheat, to 80 lb. pressure, no superheat, is done by the carton type desuperheater, with automatic controls.

A sketch (Fig. 3) shows the layout of such a desuperheating system. Each main line has a carton type desuperheater in which the carton is easily removed by taking off the lid. It is a good plan to have an extra carton, depending upon the condition of the water.

Sometimes the small copper wires become coated with a hard scale which requires time to clean properly. Condensate is used wherever possible, but where raw water only is available, the dirt soon plugs up the carton and the operation of desuperheating becomes inefficient. The first indication of a dirty carton is a rise from saturation temperature to a few degrees of superheat. It is well, in designing the system, to provide duplicate equipment throughout. The sketch shows a closed system of

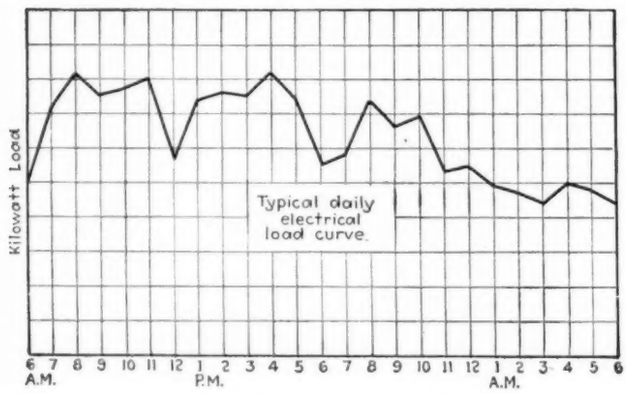


Fig. 1—Typical daily electrical load curve

this type that has proved satisfactory. No traps are used. The condensate from the steam line and water from the separator are returned to the tank. From the tank it is pumped back into the spray valve on the desuperheater.

The condensate or return tank is equipped with an automatic control valve for raw water. This is regulated by a float in the condensate tank, in which the water is practically at a uniform temperature. The capacity of this tank is such that demands for injection water are easily met.

Centrifugal pumps are used for circulating the water from the return tank to the cartons. A motor-driven and a steam-driven unit are used. The latter is controlled by the pressure on the water line, so that a slight pressure drop will operate the pump. A slight degree of superheat in the main distributing line will cause considerable disturbance with the control, and it is essential that the automatic control on the pumps function satisfactorily. It is well to have a small connection on the steam pump from the top, back into the return tank, for the pump when standing idle may become steambound. When the system is operating properly, it requires but little attention. Much depends upon the operation of the reducing valve.

Kilowatt-Hour Demand

The kilowatt-hour demand is largely governed by the schedule of the various mill circuits and the method in which they are timed. Different rubber companies have different load curves, depending upon the various compounds and the nature of breaking down the rubber. However, an illustration of this may be drawn by the chart showing the demand for maximum peaks. This is calculated in the form of "Tires produced per day." It can also be broken down in "Pounds of goods produced per day," but the "Tire" method is simple and works out satisfactorily.

The individual motor charts (Figs. 5 and 6) as shown, illustrate the severe demand on individual circuits. Should the timing of these circuits be out for any reason, the excess load will be thrown upon the demand meters. The average demand of electrical current will run approximately 0.55 kw.-hr. per tire, and the maximum 1.1 kw.-hr.

The chart (Fig. 7) shows a comparison of live steam direct to the reduction methods with that through a high-back-pressure turbine. This is based on "Tires per day." In this particular chart the point to consider a high-back-pressure turbine, will be approximately 9,000 tires per day; above that, the turbine shows an actual increase in output until at 500 kw. load it represents a 78 per cent return on the investment. This is only an illustration, as each plant will vary according to its layout and demands.

Characteristic Flow of Vulcanized Steam

Generally, vulcanizing circuits are split into groups, so arranged that 20 to 25 per cent of the presses in groups, are filled at one time.

The molds and presses, being cool, require considerable heat to bring up the temperature, over a given period. This time generally ranges from ten to fifteen minutes, after which the chart will show a slight variation in flow, due to the schedule of presses being taken from the circuit.

During the period of filling, considerable condensate has to be taken care of. The condensate, for the first

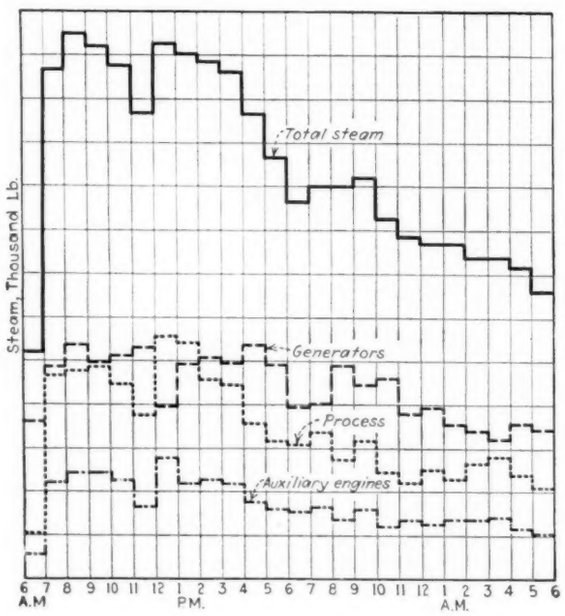


Fig. 2—Typical daily steam load curve

twelve to fifteen minutes, equals about one-half of the total consumption of the entire cure.

Where a large number of presses are timed so that they require this demand at one time, a heavy demand is made on the draining systems of the circuit. The draining system is arranged to form what is called the "central condensate collecting system." The press condensate exhaust is controlled by means of a thermostat valve set to function at approximately 217 deg. This is arranged with a reservoir outside the presses and equipped with a condenser, so that the chamber containing the water to be discharged into the system is of

sufficient size so that it will not be all drained and cause a disturbance in flow to the presses. This is important. A rapid flow at the bottom of the press causes disturbances in the instruments controlling the regulation, and

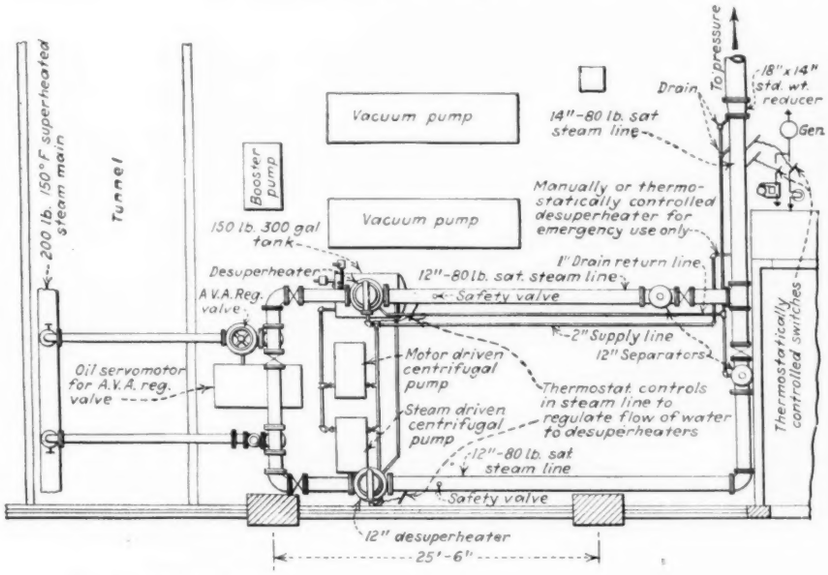


Fig. 3—Desuperheating system layout

difficulty is immediately experienced.

The central condensate system is so arranged that each press has a water leg approximately 4 ft. high, varying according to the location of the press. This is done to prevent the cooling water, which is at low temperature, from entering the condensate return line. The cooling water is not treated, and therefore undesirable in the condensate system.

The condensate system consists of a large receiving tank so arranged at a level below the bottom of the presses that proper drainage is possible. This receiving tank remains about one-half full of condensate, which enters through the bottom by means of perforated pipe. The water remains at about 212 deg., and on the top of this receiving tank is a condenser which takes care of the excess vapor arising from the water, in event of a rush of higher temperature water. This condenser is cooled by condensate from the turbine circuit. The condensate at this point, which is a considerable distance from the power house, is at a temperature of about 80 deg. and passes through this condenser, returning to the power department. This condenser drains into the main receiving tank directly below it. At times, in the operation of the press, it is necessary to open up the drain line on the bottom in order to have a rapid circulation to get the temperature at the desired time. In doing this, high temperature water is blown into the receiving tank, which of course would be blown to the atmosphere, were the condensate system not installed. It is found that this arrangement is very economical. The condensate is returned to the power department of the plant.

The central condensate system, in addition to effecting a saving, offers an advantage, in that when properly designed it will prevent water hammer in the return line, and assures positive pumping pressure as compared to the intermittent pressures induced by trap discharges, steam flashing and static heads. It also offers the advantage of a supply of hot condensate available for other purposes important to the manufacturing of tires, where uniform temperature from a reliable source is desired.

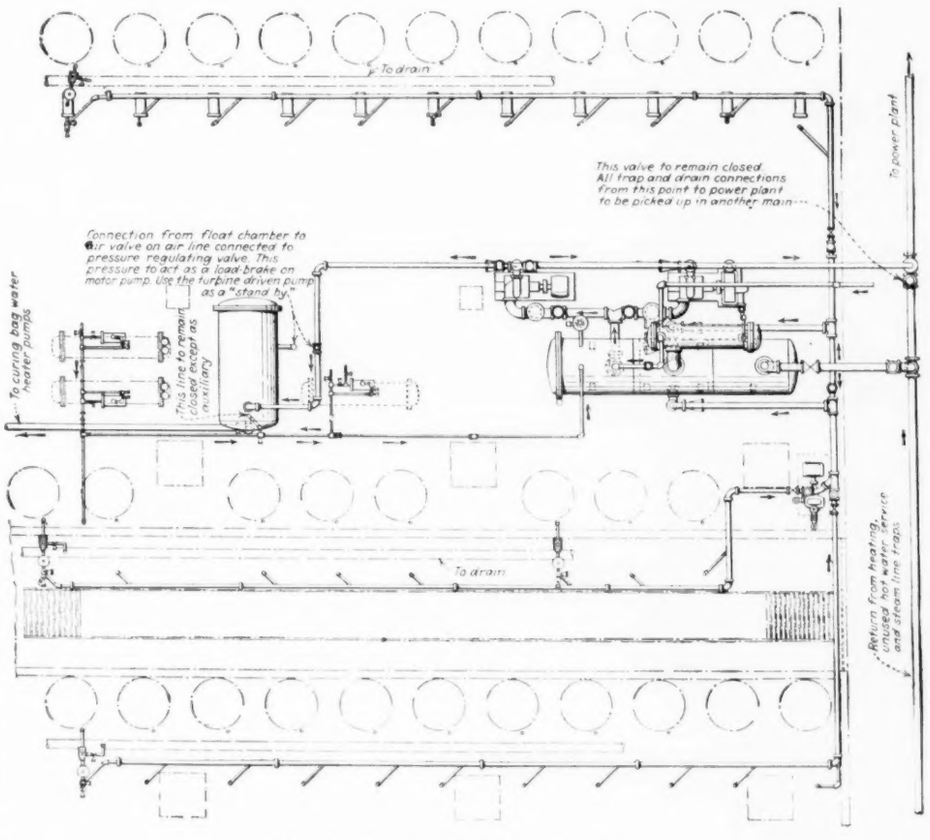

To drain
To power plant
This valve to remain closed. All trap and drain connections from this point to power plant to be picked up in another main
Connection from float chamber to air valve on air line connected to pressure regulating valve. This pressure to act as a load brake on motor pump. Use the turbine driven pump as a "stand by"
To curing bag water heater pumps
This line to remain closed except as auxiliary
To drain
Return from heating, unused hot water service and steam line traps

Fig. 4—Central condensate system

The standard basis of boiler evaporation is one of heat units, and considered from such a view point, provided the efficiency of the boiler and superheater is as high as of a boiler alone, no additional fuel is required to generate steam containing a definite number of heat units,

whether such units be due to superheat or saturation. That is, if 6 per cent more fuel is required to generate and superheat to 100 deg. a definite weight of steam, over what would be required to produce the same weight of saturated steam, that steam, when superheated, will contain 6 per cent more heat units above the feed-water temperature than if saturated. This holds true if the efficiency of the boiler and superheater combined is the same as of the boiler alone.

As a matter of fact, where a superheater of proper

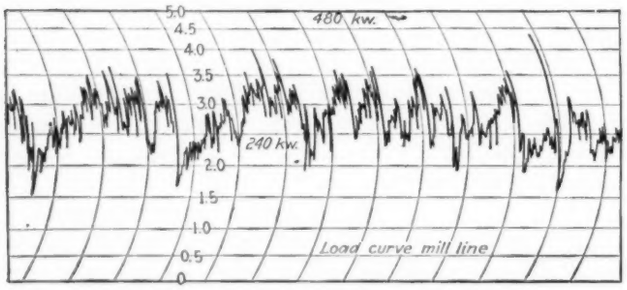


Fig. 5—Load curve, mill line

design and location is used, the efficiency will be higher for the same set of furnace conditions than would the efficiency of a boiler in which no superheater was installed. A superheater properly placed within the boiler setting in such a way that products of combustion for generating saturated steam are utilized as well for superheated steam, will not in any way alter furnace conditions. With a given set of such furnace conditions for a given amount of coal burned, the fact that additional surface, whether as boiler heating or superheating surface, is placed in such a manner that the gases must sweep over it, will tend to lower the temperature of exit gases. It is such a lowering of exit gas temperature that is the ultimate indication of added efficiency. That there is an increase in efficiency is unquestionable.

In our plant operating with two pressures and both with and without superheat, we have observed the following stack temperatures:

At 200 lb. and 150 deg. superheat, 550 deg.
At 150 lb. and 0 deg. superheat, 650 deg.

With furnace conditions the same in both cases, we find from reliable sources that this lowering of exit temperature in the case of 200 lb. and 150 deg. superheat, amounts to a 3 per cent gain in boiler efficiency with a corresponding saving in fuel costs.

In terms of evaporation, it amounts to an increase as follows:

Equivalent evaporation using fuel with a heat value of 13,000 B.t.u. and boilers operating with an efficiency of 75 per cent $\frac{13{,}000 \times 0.75}{970.4} = 10.05$ lb. steam per pound coal.

Equivalent evaporation operating at 78 per cent efficiency. $\frac{13{,}000 \times 0.78}{970.4} = 10.46$ lb. steam per pound coal.

A second saving due to superheat is lowered line losses. Superheated steam gives up its heat content less readily in pipe lines. Tests show a 50 per cent reduction in line losses when superheated steam is used.

During the year 1925 our average boiler efficiency was 75 per cent and the cost of steam averaged $0.2444 per thousand pounds. If superheaters had been used throughout and advantage taken of the added efficiency, the steam cost would have been reduced to $0.2345 per thousand pounds.

The proposition of utilizing a turbine for reduction of pressure to a point where it will be suitable for press work may be laid out somewhat as follows:

Cost of steam per hour, 40,000 lb. $\times$ 0.2345 = $9.38.

The turbine receives steam at 190 lb. gage, 135 deg. superheat, and exhausts it for press use at 80 lb., 70 deg. superheat.

Each pound of steam contains 1,275 B.t.u. as received by the turbine, and leaves with a heat content of 1,223.1 B.t.u. Therefore, from each pound, the turbine extracts 1,275.7 — 1,223.1 = 52.6 B.t.u. Since the turbine water rate is 83.3 lb. of steam per kw.-hr., the heat extracted per kilowatt-hour is 52.6 $\times$ 83.3 = 4,381 B.t.u. On 40,000 lb. of steam the turbine will produce $\frac{40{,}000}{83.3}$ = 480 kw. per hour, or 480 $\times$ 4,381 = 2,102,880 B.t.u. extracted from a total of 40,000 $\times$ 1,275.7 = 51,028,000 B.t.u.

Since the original 40,000 lb. of steam per hour cost $9.38, the proportional cost of the 480 kw. produced by the turbine will be,

$\frac{9.38 \times 2{,}102{,}880}{51{,}028{,}000} = \$0.387$ = actual cost to produce 480 kw. per hour.

However, the actual value of this power must be calculated from what it would cost to produce the same in the power house. The power-house turbine water rate is 13.5 lb. per kw.-hr., or to produce 480 kw.-hr. would require 13.5 $\times$ 480 = 6,480 lb. of steam per hour. The cost of this steam is 6.48 $\times$ 0.2345 = $1.52 per hour.

Since the actual value of this power is $1.52 per hour and it cost only $0.387 to produce it in the high-

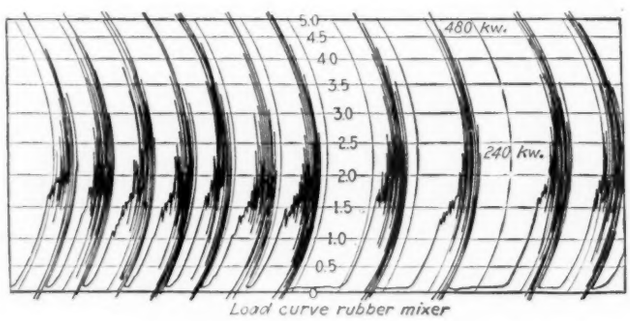


Fig. 6—Load curve, rubber mixer

back-pressure turbine, the saving is 1.52 — 0.387 = $1.133 per hour, or 1.133 $\times$ 24 $\times$ 288 = $7,831.29 per year.

Saving equals 10,506.23 — 2,674.94 = 7,831.29.

The alternate proposal for furnishing suitable steam for press work is to generate at 200 lb. and 150 deg. superheat (allowing 10 lb. and 15 deg. drop in piping) and reduce to the proper point through a reducing valve and then desuperheat. This reduction process entails a loss which may be computed as follows: The loss is the product of T_o, the temperature corresponding to the back

pressure and the change in entropy during the throttling process:

T_a at 80 lb. gage, = 784 deg. abs.

Entropy at 190 lb. gage, 135 deg. superheat = 1.6289

Entropy at 80 lb. gage, 175 deg. superheat = 1.7102

Difference = 1.7102 — 1.6289 = 0.0813

0.0813 × 784 = 63.7 B.t.u. per lb. steam.

This heat, in terms of steam, amounts to

40,000 × 63.7 = 2,548,000 B.t.u. per hour **= 1,985** lb. of steam at 200 lb. and 150 deg. superheat.

At 0.2345 per thousand pounds this equals **$0.4644** per hour, or $3,209.93 per year.

This shows a greater loss than with the steam put through the turbine, which produced 480 kw. of power.

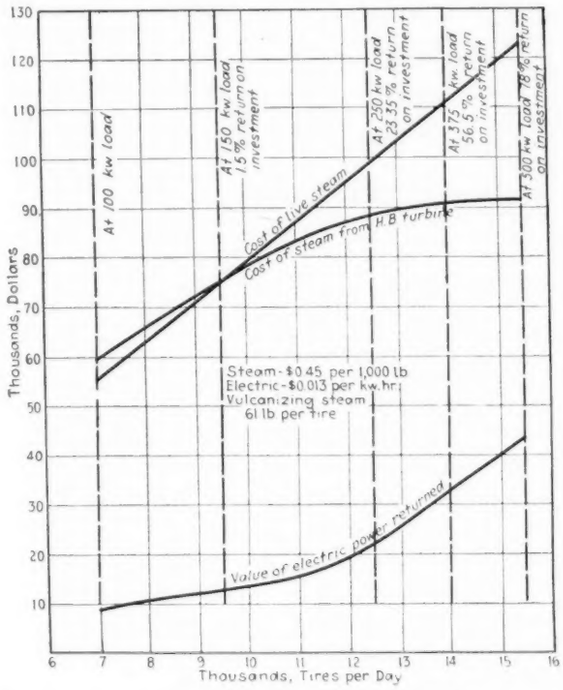

At 100 Kw load
At 150 kw load 15% return on investment
At 250 kw load 23.35% return on investment
At 375 kw load 56.5% return on investment
At 300 kw load 78% return on investment
Cost of live steam
Cost of steam from H.B turbine
Steam-$0.45 per 1,000 lb
Electric-$0.013 per kw.hr.
Vulcanizing steam 61 lb per tire
Value of electric power returned
Thousands, Dollars
Thousands, Tires per Day

Fig. 7—Comparison of live steam with back-pressure turbine

Since the turbine is in effect a throttling valve, we can be conservative and assume that the cost of steam lost through the reducing valve will only be equal to the cost of steam through the turbine; this we have shown as $2,674.94 per year. In other words, the turbine took $2,674.94 worth of steam and gave us power at a net saving of $7,831.29 per year, whereas the reducing valve took this same amount of steam and destroyed it in the process. Therefore, the turbine installation must be credited with a savings over the reducing valve of the actual value of the power produced, which we have shown to be $10,506.25 per year.

In addition, the reducing valve system must be debited with the power cost to desuperheat the steam. This is a small item and may be omitted.

The third proposal is to generate saturated steam at 200 lb. and reduce to the proper pressure.

It has been shown how superheaters add to the boiler efficiency and add approximately 0.4 lb. to boiler evaporation. Also, this added evaporation decreases the cost of steam per thousand pounds in the ratio of 10.05 to 10.46, which brings the steam cost to $0.2345 per thousand pounds instead of $0.2444.

The 40,000 lb. of saturated steam at 200 lb. will now cost 40,000 × 0.2444 = $9.78 per hour, or an increase of 9.78 — 9.38 = $0.40 per hour, or $2,764.80 per year. This represents the amount saved per year by superheating to 150 deg.

In reducing, the energy destroyed will amount to:

T_a = absolute temperature corresponding to back pressure of 80 lb. = 784 deg. abs.

Entropy at 190 lb. at 0 deg. superheat = 1.5436

Entropy at 80 lb. at 20 deg. superheat = 1.6061

Loss in throttling process = 784 × (1.6061 — 1.5436) = 49 B.t.u. per lb. steam.

This in terms of 200 lb. steam amounts to

$$\frac{40{,}000 \times 49}{1{,}198.5} = \frac{1{,}960{,}000}{1{,}198.5} = 1{,}634 \text{ lb. per hour, or}$$

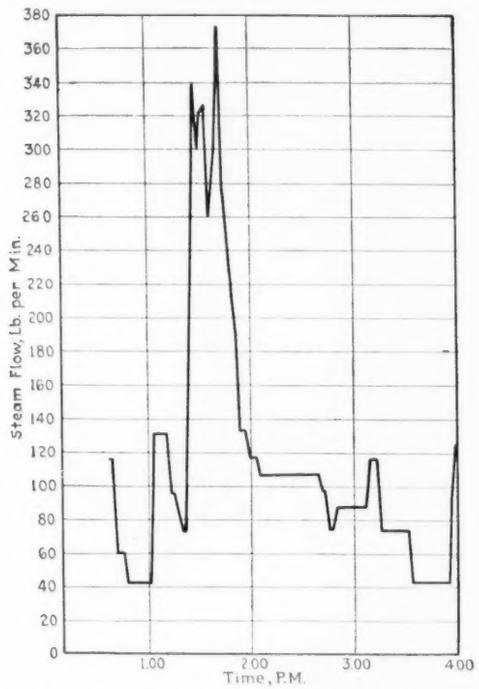


Fig. 8—Characteristic flow of vulcanizing steam

$$\frac{1{,}634 \times 24 \times 288 \times 0.2444}{1{,}000} = \$2{,}759.96$$

per year. This is the value of the energy destroyed in the reducing process.

With this proposition the turbine installation is favored on three points and shows a saving as follows:

1. Added cost to produce 200 lb. saturated steam over 200 lb., 150 deg. superheat	$2,764.80
2. Loss in reducing pressure	2,759.96
3. Saving in power value by turbine	7,831.29
Total saving in favor of turbine, per year	$13,356.05

A further loss with 200 lb. saturated steam not included in the foregoing is line losses. By using superheated steam radiation, loss in time is reduced at least 5 per cent. This loss is not readily computed but exists nevertheless.

The fourth proposal is to generate saturated steam at 150 lb. and reduce through valves to the proper pressure. This proposition would be almost identical with the third and would show approximately the same disadvantages.

Power and Fuel Situation in the TEXTILE INDUSTRY

By D. D. EAMES

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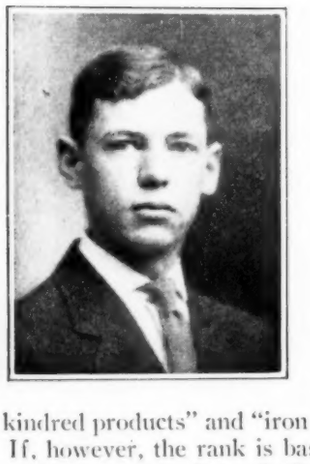


THE fundamental materials of the textile industry are textile fibers of all varieties. These include cotton, wool, silk and its substitutes, jute, hemp, flax and other coarser fibers. The textile industry as a whole occupies third place in value of products among the fourteen main groups of industries as classified by the 1920 Census Report of the United States. It is exceeded only by "food and kindred products" and "iron and steel and their products." If, however, the rank is based upon the average number of wage earners, instead of value of product, the "textiles and their products" group ranks first, giving employment to 17.7 per cent of the total number reported for all manufacturing industries.

The fuel and power requirements for this vast industry are on a corresponding scale as compared to the other principal industries.

The total cost of fuel and rent of power for all industries in 1919 was $1,646,000,000, the textile industry's share in this amounting to $81,000,000. The paper and wood pulp industry's share, by way of comparison, was $55,000,000. The fuel used by all industries amounted to 218,000,000 tons of coal and 89,685,000 barrels of fuel oil. The textile industry's share of these huge quantities was 9,240,000 tons of coal and 1,767,000 barrels of oil.

There are nine industries that use one-half a million primary horsepower, these nine being steel works and rolling mills, lumber and timber products, paper and wood pulp, cotton goods, blast-furnace industries, foundry and machine shops, steam railroad repair shops, flour and grist mill products, and manufacturers of ice. The power of these nine industries combined amounted to 14,550,000 hp., or practically one-half of the total for all industries. Steam was the primary power in all but one of them, namely, foundry and machine shops, where purchased electric current was the principal kind of power used. The textile industry's share in this total primary power requirement was 2,500,000 horsepower.

As a contrast to these figures, which indicate the magnitude of the whole industry and to give a measure of the size of the individual units, figures for the fuel consumption of different mills would show values up to 50,000 tons or more. There are many smaller mills using from 10,000 tons to 20,000 tons a year.

APPLICATION OF POWER

In the earlier days mechanical drive from waterwheels or engines was the only method of applying the power. In 1900 the Columbia Mills, Columbia, S. C., was changed from mechanical to electrical drive, thus becoming the first electrically driven textile mill. From this time one of the chief problems for designers of new mills was the choice between mechanical and electric drive. Today this is no longer a problem, as the many advantages of electric drive have caused it to supersede completely the mechanical system. Electric drive at first was applied to groups of machinery using large motors. This involved considerable amounts of shafting and belting, and there has been a steady tendency where this system is used, to limit the groups to sizes that can be driven by motors of 40 or 50 hp. There has also been an even stronger tendency to use individual motors on all types of machines.

The advantages of electric drive are, briefly, the attainment of maximum flexibility of power among departments, localization of trouble, saving of power due to elimination of the friction of heavy mechanical drive, elimination of overhead shafting and belting, giving better lighting.

An increase of production may also be obtained with electric drive because the speed of the machines may be kept nearer to standard. This increase is relatively small, however, seldom exceeding 1 per cent.

MOTORS FOR TEXTILE MACHINERY

There are conditions existing in textile mills, particularly cotton mills, which render the standard motors of other industries unsatisfactory. The two most troublesome features encountered are the presence of lint and the necessity of a relatively high humidity. The lint is drawn into the ventilating ducts of the motors, and if the air passages are small, in a short time the ventilating system clogs and the motor overheats. This is more likely to happen to small motors than to large, as the air passages are smaller. Lint also works its way into bearing housings and seriously interferes with the oiling system. To overcome these troublesome conditions the

standard motors have been modified by the use of screens to protect the air passageways or by the totally inclosed type motor. The ring-oiled bearings in the larger motors are made dustproof and the smaller motors are equipped with waste-packed bearings. The effect of the moisture from the high humidity is overcome by extra insulation of the windings. This extra insulation cuts down the radiating capacity of the windings and because of this and of the other conditions which tend to increase the heating, *50 deg. C. motors should never be chosen for textile work.*

Use of Heat in the Textile Industry

The textile industry possesses the opportunity to a larger extent than many other industries of co-ordinating its demands for power and heat. It cannot be said, however, that this co-ordination has been worked out in any complete way except in a comparatively small number of mills. Several reasons could be advanced for this, such as failure on the part of managers to understand that such co-ordination with its attendant savings is possible or unwillingness on the part of operatives to adapt themselves to new conditions of operation. Inability to find necessary capital has also doubtless deterred many mills from making the changes, even after a full realization of their desirability.

There is without doubt at the present time a growing realization of the savings that may be made by the use of byproduct steam and power. In fact, this may be said to be the outstanding feature of the textile power situation today. The principle involved is simple. An engine or a turbine is a machine that converts heat into mechanical or electrical energy. When heat is supplied through the medium of steam, the engine or turbine uses a small proportion of the heat and there remains in the steam a sufficient amount for use in many of the textile processes. In other words, the steam can be made to do double duty, first generating power, then being used, for example, in the heating of water or drying of cloth.

A great many variations of the method of applying and utilizing the steam or heat may be made, thereby providing the diversity needed to suit the varying conditions found among the mills. In the initial steam condition the pressure and superheat may be set at the most advantageous point. The steam for process may be extracted from a condensing turbine at whatever pressure is most suitable, within fairly wide limits, or the turbine may be straight non-condensing, exhausting at the desired pressure. In other plants the turbines are operated condensing and the heat utilized in the form of the warm condensing water.

Use of Steam in Textile Processes

A brief outline will be instructive of some of the textile processes in which steam or warm water produced by the methods referred to can be used. Building heating is not a textile process, but is essential for all textile mills in the United States. The use of exhaust steam for heating might be considered elementary and supposedly understood by every mill engineer. But this is not necessarily the case. The master mechanic of a fairly large mill to whom the writer was once advocating the use of exhaust steam for heating remarked that exhaust steam was all right for "summer heating," but would not do at all for his plant in winter.

Some of the heat-using processes of the textile industry might be classified as follows:

Drying—all materials.
Dyeing—all materials.
Tentering—cottons and worsteds.
Scouring—wool.
Combing—wool.
Kier boiling—cotton goods.
Calendering—cotton goods.
Steaming—worsteds and print goods.
Washing—woolen and worsted goods.

In some of these processes the steam is brought into direct contact with the goods, in some the goods are in contact with heated surfaces, and in others the steam is used directly for heating or boiling liquids. It is safe

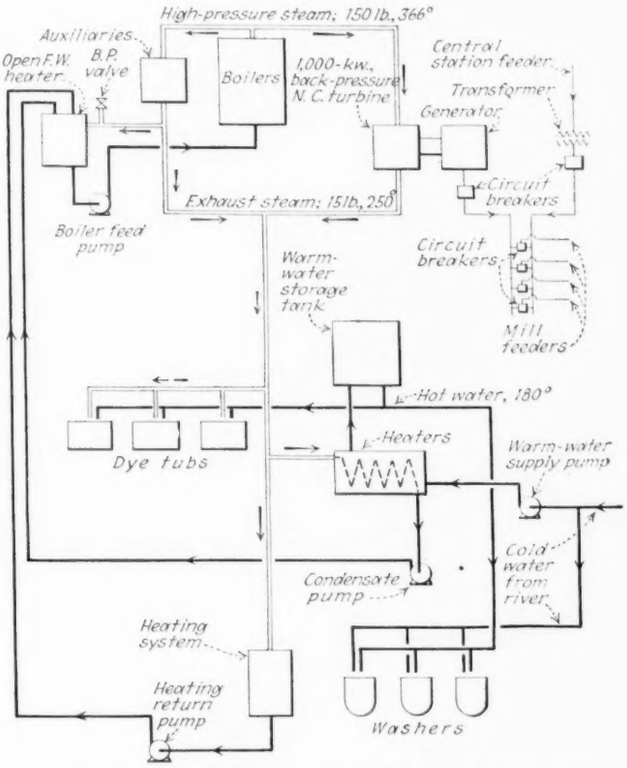


Fig. 1—Steam and byproduct power diagram for worsted mill

to say that all these processes except tentering and kier boiling can be successfully served by steam extracted or exhausted from turbines at 15 lb. pressure or less.

It is true that failures have been reported in attempts to use low-pressure steam in these processes, but the success that has followed similar attempts in many other instances should make it evident that some local condition is at fault rather than the idea as a whole. One condition, for example, which is sure to make trouble is the endeavor to distribute low-pressure steam through the same piping system as was used for the original high pressure. The low carrying capacity of the small steam pipes under reduced pressure conditions will invariably slow up the process work and more likely than not lead to an undeserved rejection of the low-pressure system.

The most advantageous system of power and steam apparatus for a particular case will depend on all the circumstances involved. Such circumstances would in-

clude the correspondence in use of power and process steam, the relative amounts of each, and the initial and process steam pressures as determined by existing conditions at the plant. Some plants require process steam at pressures well below the boiler pressure. In such plants non-condensing turbines can be installed when all the exhaust can be used in process work, or extraction turbines when the power requirement exceeds that of the process. In some cases where there is a large demand for warm water, this can be used to even up the irregularities in use of steam, thereby maintaining a steady power load on the turbine without wasting exhaust. This, of course, requires ample storage capacity of hot water.

In worsted mills, print works and finishing plants of all kinds an abundant supply of warm water is essential. The heating of this water constitutes one of the major items in the use of steam. There are two ways of furnishing this hot water. It may be heated by extracted steam or by the exhaust from a non-condensing turbine, part of which goes to points where steam is used directly, or the turbine may operate condensing and the condensing water be used for the process. The latter system has advantages where it can be used, chiefly that the steam rate of the turbine is not affected even if the demand for warm water ceases.

It is desirable that a non-condensing turbine operating in a byproduct power system be run in parallel with another source of power, such as a central station feeder or a condensing turbine in the same station. When this is properly arranged the turbine generating process steam will be operated only at the capacity necessary to furnish the required quantities of exhaust, the other source of power making up the deficiency in the most economical manner.

In a certain worsted dyeing and finishing plant all steam for process, including building heating, is passed through a 1,000-kw. turbine. The steam pressure at the turbine throttle is 150 lb. with superheat, and the back pressure is 15 lb. The exhaust is piped to the dyehouse and other parts of the plant and to warm water heaters through which a forced circulation of water is maintained, discharging to overhead warm-water storage tanks. This turbine operates in conjunction with the local central station system up to the requirements for 15-lb. steam. The remainder of the power is purchased. This has proved to be a satisfactory arrangement with high over-all efficiency.

In another finishing plant all power is generated in condensing turbines and the demand for warm water is sufficient to utilize all the condenser discharge. Other demands for steam are supplied direct from the boilers through reducing valves as required. This plant has also shown a high over-all efficiency.

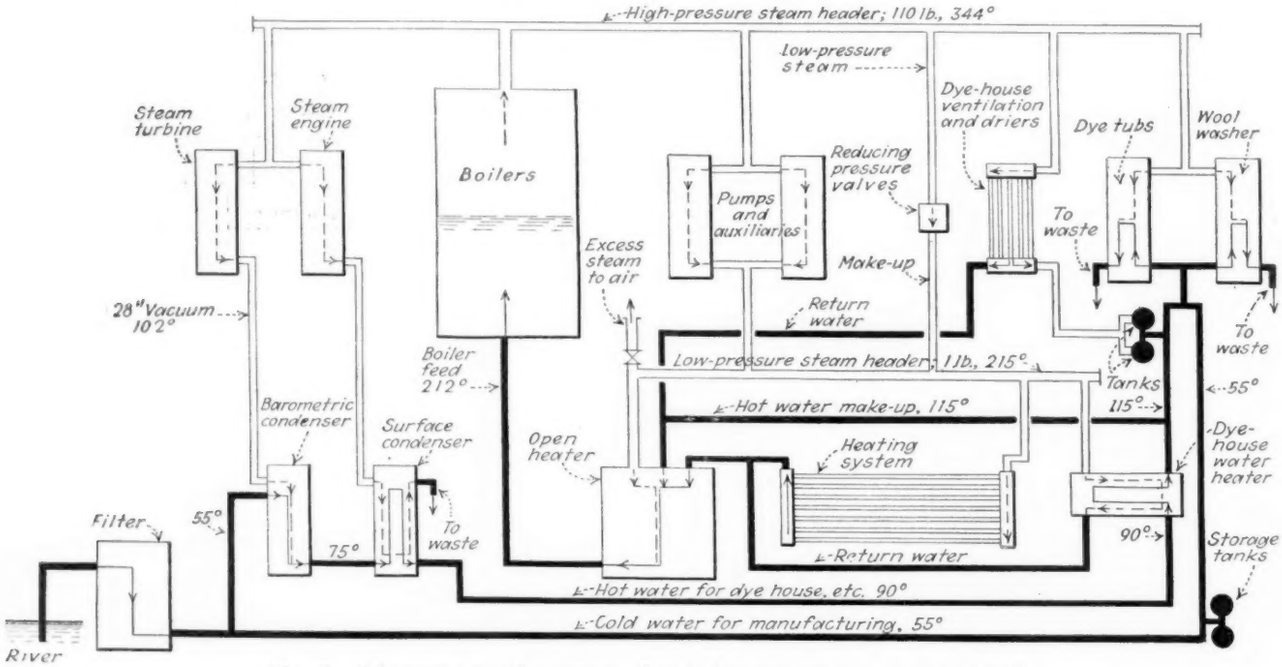


Fig. 2—Diagram showing water circulating system at a worsted mill

Figs. 1 and 2 show diagrammatically the arrangement of steam and warm water lines for the two examples described.

High-pressure steam, as the term is applied today to industrial power plants, means anything above 250 lb. A large amount of pioneering in this field is going on, principally by central stations. The textile industry will present many cases where a moderately high pressure, 400 lb. for example, will afford a lower over-all cost of process steam and power than could otherwise be obtained. The particular cases where such a system can be used are those where there is a considerable demand for process steam at 80 to 100 lb. pressure or more. If there is also a demand for low-pressure steam, a double extraction turbine will work in to advantage.

It has been pointed out many times that there is only one advantage to high-pressure steam, namely, that it may enable one to get more power from the same weight of steam. Everything else about, in the writer's opinion, is a disadvantage. In a textile power plant the first things to be considered are simplicity and reliability.

The cost of power and steam is only a fraction of the total cost of production, and shutdowns even of short duration are very expensive. If the use of high-pressure steam reduces the reliability factor or detracts from the simplicity that is so desirable for industrial plants, then its adoption should be considered with great care.

On the other hand, there are many plants, as has been suggested, where a high-pressure steam installation will earn so much money that it cannot be rejected except for the weightiest of reasons. There is, furthermore, the reasonable expectation that with the more frequent use of high-pressure apparatus, the difficulties that now exist will be overcome and a more general application of its advantages will be practicable.

Purchased Power

Average rates for purchased power are higher by a small amount than the cost of generating power in a new isolated plant for a textile mill when there are no adverse conditions. This is doubtless a result of the law of supply and demand, as it is improbable that the central station will sell cheaper than the average isolated plant cost, and if its rates are much higher it cannot sell much power. The size of the plant and the load factor have little influence on the relative cost. These statements are true only in the case of new plants where power can be purchased without any sacrifice of existing investment and where steam is needed only for power.

In the case of a going plant it is seldom that a central station can make a favorable showing. This is because of the effect of the fixed charges on the investment already made in the private plant. The purchase of power in this case will save operating cost only.

The demand for a small amount of steam for heating or process work does not generally alter the relations as given herein, but in those mills having a large demand for steam for heating water and drying cloth, the private plant has a decided advantage. Every case is a separate problem, however, which must be studied and decided on its own merits. One of the factors to be studied particularly in such a case would be the relation between the time and the amount of steam used and the time and amount of electric current. It sometimes happens that the diversity of these two factors is so great as to nullify what looked at first like a decided advantage to the private plant. A case of this kind cannot be decided on the basis of average figures, but only with full knowledge of all conditions.

Another factor to be considered in connection with purchased power is that by its use a large investment for power plant equipment may be avoided. The difference in cost of purchased and generated power will often amount to such a small return on the power plant investment that the mill owner will find it more desirable to purchase his power and spend the extra money in the mill rather than in a power plant.

Conclusion

In conclusion it might be emphasized that the present economic situation of the textile industry makes imperative both the conservation of capital and the establishment of all possible operating economies. Those mills that have demands for quantities of process steam or hot water have the opportunity of so co-ordinating their steam and power as to effect material savings.

Freezing of Gages in Cold Weather

By L. G. Jones

IT WILL soon approach the season of the year when precautions should be taken to prevent the freezing of any equipment. In industrial plants where buildings are walled with sheet iron, and when the infiltration of cold air is large, water-containing devices that have no circulation are likely to be ruined by freezing.

This applies particularly to gages and meters that contain water and have lead lines of small bore with no flow of the contained water. These lines may lead from the top of the boiler along a wall through a cold zone, where they would easily freeze.

The writer has seen cases where the water column blowdown lines froze and had to be thawed out before blowing down. In this plant boiler flow-meters and several venturi meters froze and burst, and in addition about half of the individual boiler-pressure gages had their Bourdon coils ruined.

Cold snaps come suddenly, and it is wise to be prepared. Preparation is simple and, once undertaken, relieves further worry and loss.

Pressure gages may be protected in four ways:

1. Fill the lead line with alcohol to form non-freezing mixture.
2. Fill the lead line with kerosene, which will not freeze.
3. Run steam line down along the lead line to gage and cover the combination lines.
4. During a cold snap crack the gage drain cock and allow a faint stream of steam to escape. In this case correction for loss of water head on the gage is necessary

Flow meters may be protected in two ways:

1. Fill lead lines and meter with non-freezing alcoholic solution.
2. Run steam line along lead lines and coil around meter.

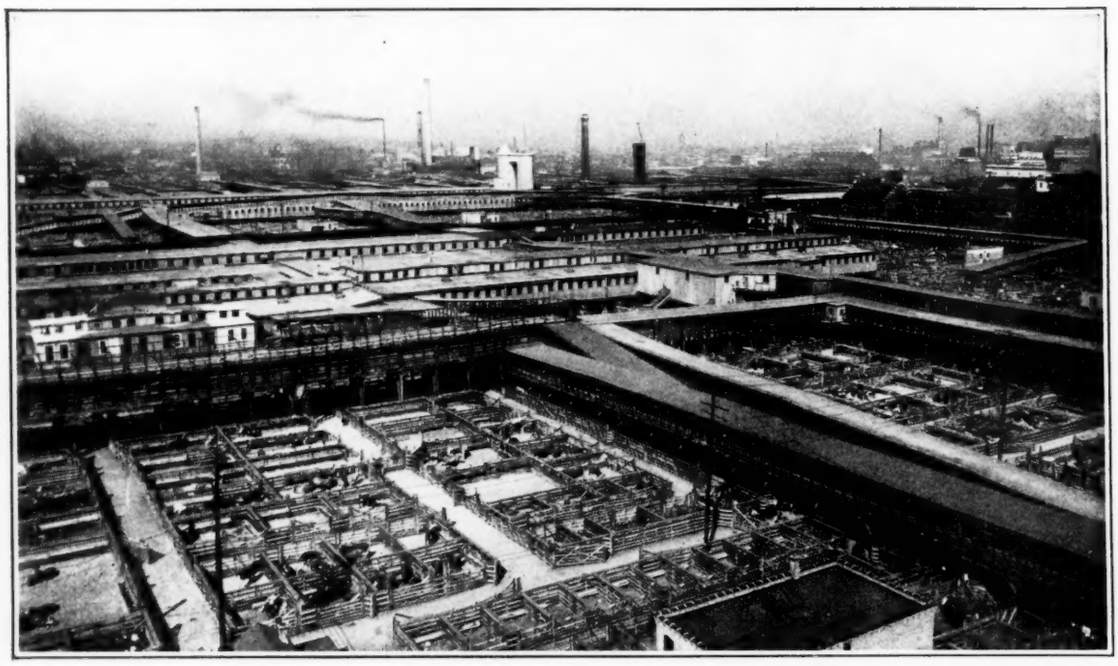
If no protection is available, all valuable instruments should be drained for the winter or for cold spells particularly, as weather forecasts are available to give notice of approach of freezing weather.

Some Diesel Service Records

A REPORT just issued by the Busch-Sulzer Bros. Diesel Engine Company contains the operating record of one hundred Type B engines that have been in service from three to twelve years. The figures are both interesting and useful, especially as offering something definite on the maintenance of Diesel engines—a subject upon which the non-user is often misinformed.

The engines range from 120 to 520 b.hp. A complete tabulation in the form of an insert accompanies the report, but the following represents some of the high points of the data offered:

Total time in actual operation (average of 67 engines)	31,770 hours
Total time in service (average of same 67 engines)	6.4 years
Per cent operating time to total (based on same 67 engines)	56.5
Average duration of run between stops (based on 82 engines)	236 hours
Average duration of run between overhauls (based on 92 engines)	19.2 months
Average time between routine inspections (based on 92 engines)	45 days
Average time between removals of heads and pistons (based on 92 engines)	15.95 months
Piston-pin bearings	16 replaced on 8 engines—none on 92 engines
Crankpin bearings	62 rebabbitted out of 400
Main bearings	25 rebabbitted out of 500
Liners replaced	The average age of liners replaced was 6.88 years
Cylinder heads replaced	One per engine per 5.5 years
Pistons replaced	One per engine per 7.8 years
Working cylind. rings replaced	Five per engine per year
Compressor valves replaced	One per engine per 1.6 years



Packing-House Power-Plant Problems

By O. A. Anderson*

IN THE budget of annual operating expenses in the packing house the cost of supplying the necessary steam, electric power, refrigeration, air and water services is a substantial item. Within our particular organization this expense involves an item of ten million dollars and upward per annum. It is apparent from the magnitude and importance of these services, that judicious designs and control present possibilities of tremendous savings to the individual corporation and the industry.

Many of the large packing houses have been established and in operation over a period of between twenty and thirty years. Practically all of them were originally equipped with their own power plants, which consisted of steam boilers of ample capacity to supply steam for all the packing-house department process work as well as the necessary steam for electric power generators, refrigerating machines, air compressors and pumping equipment. During these years the requirements for steam have increased as a result of the continued expansion of electric-power-driven machinery, which has gradually taken the place of labor throughout the plant. Furthermore, there has been a continued increase in hot-water requirements for sanitary and processing purposes. These trends have been reflected in increased electric power, greater generating capacity and enlarged water-pumping and water-heating facilities.

In the early stages of the industry the standard refrigerating machine was the steam-driven Corliss condensing type, low-speed unit, operating at speeds varying from 50 to 75 r.p.m. The refrigerating plants consisted originally of direct-expansion ammonia piping systems. During the last fifteen years there has been a gradual increase in the application of the brine circulating system, which has further increased the pumping requirements, and in so doing, enlarged the steam demand.

During the last ten years it has been necessary, from time to time, to make some major replacements in steam generating and fuel burning equipment, as well as consolidation of power plants, which has brought about a consequent reduction in the total power plant operating expense. In the present-day period of keen competition in every industry, however, large expenditures for machinery and building replacements cannot be made until all possible means for improving the service with the available equipment have been thoroughly searched out. In cases where the necessary economical combinations and savings cannot be effected within the particular plant, careful and seasoned study will have to be made along the lines of purchasing from the utilities the necessary energy requirements. Inasmuch as portions of the major boiler room and refrigerating equipment of Armour &

*Engineering Division, Armour & Company, Chicago.

Company are beginning to approach the end of their useful life, it will be necessary that a definite program and policy for the future power plant be outlined.

In view of the fact that the packing-house process work consists primarily of cooking at different temperatures, an opportunity is afforded to pass the steam through the prime movers of the power plant before utilizing the exhaust steam for the various cooking and heating processes. Substantial strides have been made in developing the applications for low-pressure exhaust steam by supplying more liberal heating surface, larger piping connections and proper insulation. Notwithstanding, the means of using low-pressure steam in the processes still presents a large field for development.

The plant that ultimately will continue to exist on a sound economical basis will be the one that has the nearest approach to a perfect heat balance. In other words, the steam-driven ice machines, air compressors, power units and pumping equipment will be justified to the extent that all exhaust steam from these units will be used for the heating of water and buildings and for plant process cooking. The remainder of the refrigerating energy, power service, etc., will have to compete with purchased power from the utilities.

With the prime mover output supplying exhaust steam for useful heating work, the utilities cannot compete, but generation of the balance of the power requirement is strictly a matter of economics as to whether the individual plant can produce the energy at a price that will show enough saving over the purchased service to offset capital expenditures. It will be realized, of course, that there is a distinct difference between plants on which the full investment for power generation had been made and those in which new expenditures are required. It is imperative, therefore, that a definite program of necessary expenditures be formulated over a period of years, so that a sound policy may be followed.

In arriving at the heat balance, there are a number of things to be considered. Generally speaking, there might be an inclination to accept the hypothesis that if there is use for the exhaust steam, it does not make any material difference whether an economical or an inefficient prime mover be used. This would be true if there were an unlimited demand for low-pressure steam as compared with the steam required for prime-mover purposes.

Analyzing the operations of one of the company's most modern plants, it was found that for a given period the power plant required approximately 35 per cent of the total steam generated in the boiler room. This left a balance of 65 per cent to the departments of the packing house. In view of the fact that this 35 per cent figure is the result of operating condensing a good portion of the prime movers at a water rate of 14 to 16 lb. per horsepower-hour, it is certain that if uneconomical non-condensing equipment be utilized, the percentage of steam required by the power plant soon would be in excess of the steam required by the departments. A waste of exhaust steam would prevail and the total net result would be even worse than our past performance, where operation is largely condensing. The point we would like to make here is, in supplying exhaust steam for process work, we should pass this steam through the most economical prime mover possible, in order to get the greatest amount of work out of the steam before it is used for heating. This arrangement will cumulatively permit a greater portion of the power plant to operate non-condensing.

We must of necessity look to the mistakes of the past in order to anticipate properly the logical plan for the future. In view of the tremendous increase in pumping duty, mentioned in a previous article, in these columns, the total pumping requirements involve an item of 13 per cent of the total steam generated. This compares with 12 per cent for power and lighting and 18 per cent for refrigerating machines. In the main, the pumping units have been driven by small non-condensing turbines using steam at a rate of 50 to 60 lb. per brake horsepower-hour, which increases as the equipment ages in service. The result is that these uneconomical pumping units are supplying all the necessary exhaust steam for the packing house, and the power and ice machine units continue to operate condensing.

Generation of power to the extent of supplying the exhaust steam requirements is advocated, and to get maximum recovery, the use of highly economical non-condensing prime movers. The balance of the power must compete with utility service. Reference is made to improvements in the refrigerating field that are effecting economies and to a decided trend toward reducing steam pressures for process, to the end that a more perfect heat balance may be established.

It will be agreed that the steam-driven ice machine would be a much more economical non-condensing unit, requiring not more than 20 to 22 lb. of steam per indicated horsepower-hour, as compared to the 50 or 60 lb. for the turbine-driven pumps. To effect an economical heat balance, it is apparent that the pumps will have to be either electrified or replaced by economical reciprocating high-duty pumping units. Where a major expenditure in boiler equipment is involved, it is quite possible that this steam-turbine-driven pumping equipment can be electrified and electric current purchased at an attractive rate, particularly in view of the fact that the pumping load is uniform and prevails through the major portion of the 24-hour period, the pumping duty consisting of ammonia condenser work, brine pumping, and a liberal portion of house water pumping.

There are several other methods of effecting economies that have been utilized, owing to existing plant conditions, but which, in the ultimate heat balance of the future plan, will not prove sound. In certain existing plants a mixed-pressure turbine has been installed to make use of an over-abundance of exhaust steam. This has effected a saving over the original operating condition, but as the steam has not been utilized from a heating viewpoint, it probably would be better in the ultimate plan either to purchase the energy, when machinery replacements are considered, or use an economical straight condensing turbine unit.

When exhaust steam is in abundance, another use for it considered economical is in the absorption refrigeration

plant. Frequently, however, non-condensing turbo-driven brine pumps and steam-driven liquor pumps are in operations which supply the exhaust steam at an economical rate, so that in reality only a small amount of exhaust steam from the rest of the plant is utilized. Furthermore, this steam is not used strictly from a heat processing point of view and the relative economy is no greater than with the average condensing type of compressor unit. However, all these things must bear correction, based on the economics of the space available for the refrigerating equipment, building structure, etc.

High-pressure turbines exhausting at a back pressure of 80 to 100 lb. have been applied in a few instances, but in view of the capital investment in high-pressure boiler equipment and the poor economy of the turbines operating under these conditions, this plan presents nothing attractive from a water rate point of view.

Economical Non-Condensing Units Necessary to Get Maximum Energy

Looking into the future, it would appear logical that the large public utilities are going to be able to offer electric power rates so low that the packing industry cannot afford to generate electric energy except to the extent of supplying the low-pressure steam requirements. To get the maximum amount of energy from the steam supplying the low-pressure process demand and thereby reduce to a minimum the net energy that may have to be purchased, it will be necessary to install highly economical non-condensing units. In addition, of course, it will be necessary to continue to supply high-pressure steam for process work requiring it. This program will not materialize fully, however, until such time as capital expenditures for additions and replacements come up for consideration.

In common with many other industries the packing plants have been established for a long time and the processes were developed originally on a "rule of thumb" basis. This method is gradually passing out of the picture, and as improvements are made from time to time, the demand for the higher steam pressures for process is becoming less. A large perecentage of the process work involves the heating of water and maintaining temperatures that are well within the range of ordinary exhaust-steam temperatures. Hot water can be supplied at temperatures of 190 deg. and stored in vats, rather than opening up high-pressure steam lines to heat cold water directly in these vats. Much the same condition exists in the cooking of hams and sausage, some phases of lard and oil refining, the heating of smokehouses with steam coils, maintaining temperatures of around 145 deg. in hog-scalding vats, etc. With a 15-lb. exhaust pressure as the maximum, giving a temperature of 250 deg. F., it is surprising to notice the number of processes and products that come within the scope of this temperature.

Continuous Versus Batch Processes

Another viewpoint on the use of steam from the boilers under high pressure is the gradual development and application of continuous processes, rather than batch processes, which results in more uniform steam requirements and the elimination of sudden peaks calling for extra boiler capacity and uneconomical load conditions.

There are a number of practices that have proved convenient and practical, but unfortunately continue to be uneconomical. The reducing valve in particular has been an offender. In a great number of places steam is being reduced from pressures of 150 lb. in stages, first down to 80 lb. and then ultimately down to 5 or 10 lb., with a throttle valve for open hot-water heating and cooking. This expansion of the steam has taken place without any recovery in energy. Proper piping arrangements and facilities for removing condensate frequently overcome objections to the use of lower pressures. Another item of waste is the standard water steam-heating mixing valves. There are instances where closed-coil heating and jacket-heating can be applied successfully and the condensate returned to the boiler room, as compared to injecting steam directly into the water or process material.

Refrigeration in the Packing House

One of the major services rendered by the packing-house power plant is that of refrigeration. Considerable development and improvement is taking place in this field. The vertical shell-and-tube condenser affords an economy in heavy building structure replacements and low pumping head, as well as a reduction in depreciation, as compared with the atmospheric type condenser. Progress is being made on the evaporating side in the skillful design and operation of shell-type brine coolers with ammonia level regulators. Improvement in evaporating equipment and gradual correction in sizes of ammonia suction lines is bringing about a higher back pressure, reflecting in less horsepower used per ton of refrigeration.

With the advent of the brine spray system has come the possibility of chilling carcasses in 24 hours, thereby ultimately reducing the capital expenditures and maintenance from operating a lesser number of coolers and effecting a saving in interest on money tied up in carcasses, owing to the quick handling of the product.

The packing industry carries a tremendous investment in cold storage space, and owing to the rapid transfer and movement of product in and out of these coolers, the maintenance is of necessity a large sum. Progress is being made and will have to continue toward the end of perfecting these facilities so that an ultimate reduction of maintenance will take place and revert into increased earnings for the industry.

In conclusion it is well to bear in mind that the solution to the power plant problems does not lie in the scrapping of all the present equipment and building anew, but rather adapting as much as possible of the present equipment to better operating economy and improving the uses of heat in the packing-house departments.

Capacity of Prime Movers and Electric Motors in Manufacturing Plants

Basic figures from Bureau of the Census.

Item	Horsepower (Thousands) 1914	1923	1925
Prime movers owned by factories	18,406	19,728	35,773
Electric motors operated by purchased current	3,885	13,366	15,869
Total power equipment	22,291	33,094	51,642
Electric motors operated by prime movers owned by factories	4,939	8,821	10,255
Estimated capacity of factory prime movers used to actuate motors	3,550	6,350	7,380
Total power "electrified"	7,435	19,716	23,249
Per cent of "electrification"	33	60	45

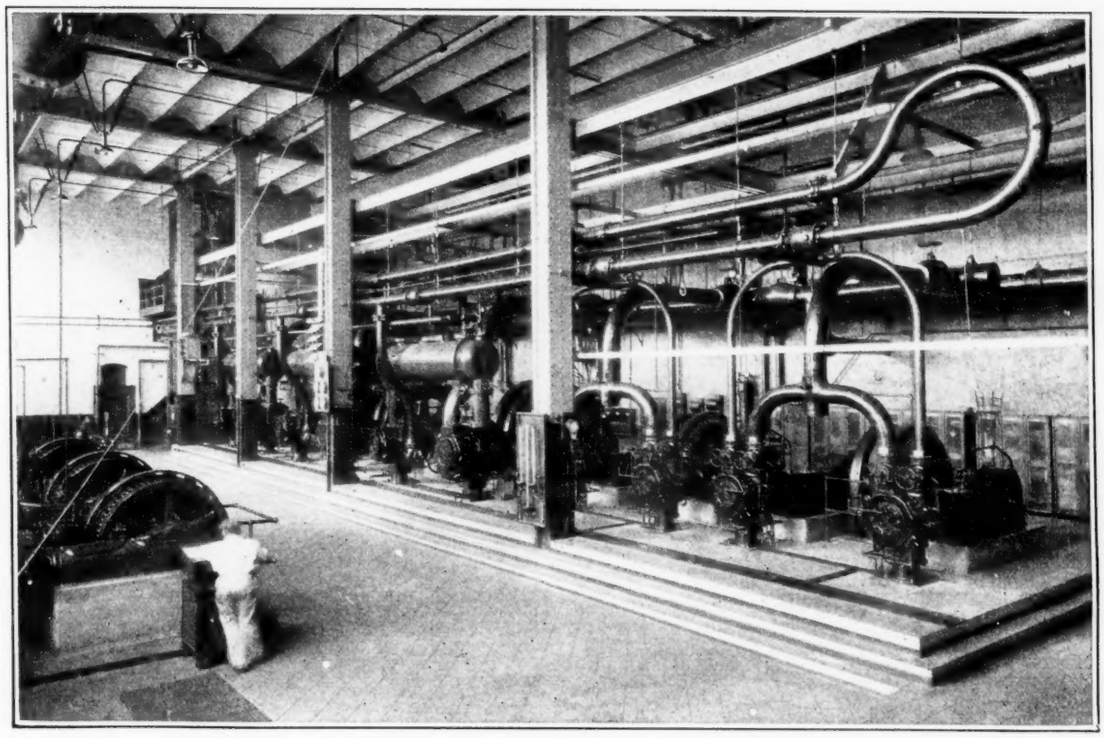


Fig. 1—Compressor room for 1,000-ton per day ice plant

Applying Electric Power to

Refrigerating Plants

Features of design that insure continuity of service with low operating and maintenance expense and supply refrigeration at a minimum cost*

ELECTRIC machinery in ice plants using purchased power can be divided into five main classes: Incoming power service, including switchroom and transformer room; switchboard for power distribution; engine-room machinery; ice-tank-room machinery, including apparatus in the ice-storage room; and lighting. Ice plants using purchased power are here considered, since, owing to the good load factor and power factor of these plants, rates made by the various central station companies are attractive, and in many cases that form of service is used.

Usually, a high-tension power supply is furnished a refrigerating plant and the owner provides and maintains the necessary transforming equipment. In some cases the power company supplies and maintains the transformer equipment, which is located on the customer's premises, and a 220- or 440-volt service is delivered at the customer's switchboard, which is generally three-phase 60-cycle power. Service is furnished on a maximum demand basis on a guaranteed yearly contract, and where a power company has a peak lighting load, which occurs mainly in large cities, special provisions are made, limiting the demand during the peak load. This does not affect the operation of the plant, as these limiting periods occur only during the winter. On the other hand, the limiting provisions permit the power company to furnish power at a lower rate than would otherwise be possible.

The ruling of a typical power company limits the demand so that no service in excess of 20 per cent of the highest preceding maximum demand of the year shall be required on any business days (all days except Sundays and legal holidays) between the hours of 4 p.m. and 8 p.m. during the consecutive months of November, December, January and February. Where service is used in excess of this percentage, an additional charge for each kilowatt of excess demand is made, but such excess demand is rarely if ever necessary.

Taking a case where power is supplied at, say, 13,200 volts, three-phase, 60 cycles, a switchroom must be provided to house the switching equipment of the power company. Some companies have standardized on truck-type switching equipment, which, although of higher first

*The information for this article was supplied by the R. B. Engineering Corporation, Consulting Engineers, New York City.

cost, introduces a high factor of safety. In the switchroom the power company places its metering equipment. Sometimes an oil switch is installed in the switchroom so that power to the transformer bank can be cut off without operating the power company's switches. Such an oil switch should be of the same type as that furnished by the power company, to line up with the other equipment in the switchroom. It should be non-automatic and should not have a no-voltage release coil.

From this oil switch power is fed directly to the transformer bank. To insure continuity of service, the most economical way is to have a spare transformer. A further step to insure continuity of service, but which is economically justified only in a very large plant, is to provide four transformers and have them large enough so that two operating open-delta will carry the load. In this case the transformers should be so designed that when three are operating in a closed-delta bank at normal operating load, the highest efficiency will be obtained.

In order to take full advantage of the value of the spare transformer, the transformers must be connected delta-delta and both the primary and secondary wiring must be so arranged as to facilitate the removal of any transformer from the system and to obtain this in as foolproof a manner as possible. Such a method of connection is shown in the diagram, Fig. 4, and a bank of transformers connected in this manner is shown in Fig. 2.

It will be seen in the diagram, Fig. 4, that by using on the primary side a common junction box and by connecting two leads directly to one terminal of the transformer, one lead being one phase of the power supply and the other lead a connection to one of the other transformers, it is possible to connect up the entire primary side of the bank without the use of soldered joints.

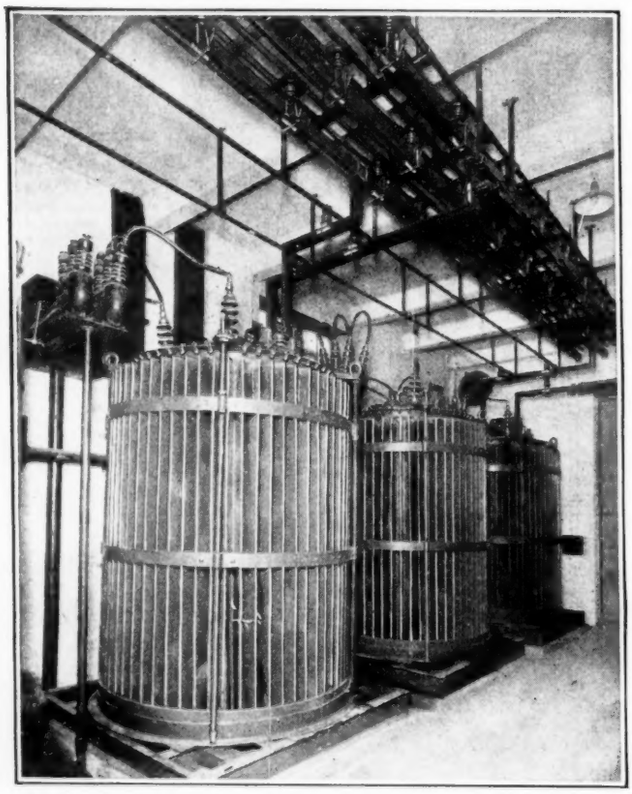


Fig. 2—Transformer connections are arranged for quick change to spare unit in emergency

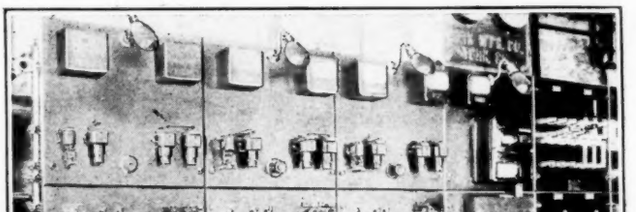


Fig. 3—Automatic across-the-line starting panels for synchronous motors

By using disconnecting potheads and an emergency primary feed to the spare transformer, Fig. 4, and a disconnecting pothead on this emergency feed at each transformer, it is possible to connect the spare transformer quickly if desired, by using short jumpers between the disconnecting potheads.

On the secondary side the layout is so arranged that the leads on any one transformer, when transferred to the spare transformer, cannot be connected to any but the right buses. The disconnecting switches permit quick operation on open-delta, but owing to their extra cost they are sometimes omitted. Their omission may also simplify the installation, particularly when not much space is available. With this method it is impossible to have a short-circuit and the connections can be made easily.

The location of the switch and transformer rooms, which can be most conveniently arranged adjacent to each other, will vary with each installation, depending on the conditions. They should be so located as to be convenient to the incoming power supply and to the switchboard, the position of which depends on that of the compressor-room equipment.

Proper ventilation should be provided in the switch and transformer rooms, an exhaust fan being placed in the latter to create a circulation and louvres are placed at proper points. The transformers and bus structure should be so located as to permit removal of any transformer outside of the room for repairs, without interrupting service other than to disconnect the transformer from the line.

Switchboard for Power Distribution

In a large installation 440-volt power distribution is used, and special transformers furnishing 110-volts are provided for supplying the cranes, ice conveyors, ice scoring machine and ice stacking machine. The latter three

devices may be connected to the lighting circuit, but it is not generally desirable. In smaller installations 220-volt power distribution from the main transformers is used throughout. In some installations the main transformers are tapped at the middle point of the winding and a three-phase voltage, 50 per cent of the supply voltage, is furnished to a starting bus for starting the synchronous motor equipment. This practice, however, is not to be generally recommended.

Secondary power from the transformers is connected to the switchboard bus. The switchboard should preferably be completely dead front with an ample aisle behind it. The circuit-breaker and disconnecting-switch equipment should be mounted on a pipe framework. This method, while requiring more room, permits of ready inspection and maintenance and provides safety for the workman.

There is a growing tendency to start the synchronous motors driving the ammonia compressors by connecting them directly across the line by means of automatic starting equipment. This is preferable although more expensive. Automatic across-the-line panels cost approximately $200 more than a hand-operated compensator panel for 2,300-volt service. Where auto-transformers starting is used, it is best to provide two auto-transformers with proper primary and secondary double-throw switches so that either may be used on a starting bus common to all machines, as in the diagram, Fig. 9. Either auto-transformer should be capable of starting the largest machine.

A further element of safety is introduced by interlocking the starting and running switches on each motor. Also, auxiliary switches should be provided to disconnect the main switch on the auto-transformer automatically when the running switch of the motor is closed, to prevent burning out the auto-transformer if the operator fails to open the switch after starting the machine. The main switch on the auto-transformer should be provided with a red and a green pilot light to show if it is in the closed or open position.

It has been found advantageous to add a buzzer to the main switch of the auto-transformer to operate as long as the switch remains closed. This extra precautionary measure costs little and acts as a piece of supervisory equipment.

Too much emphasis cannot be laid on the necessity for designing the switchboard so that all parts and oil switches can be readily disconnected from the line for maintenance and repairs. All field rheostats should be so mounted as to be readily accessible and may be mechanically or electrically operated. Rheostats, unless small, should never be mounted on the back of the switchboard.

A recording wattmeter should be provided to serve as a check and record of the maximum demand as well as a complete record of the plant's operation at all times. A watt-hour meter may also be used as a check on the power-company's instruments. All synchronous motors should have their no-voltage release coils connected to the exciter direct-current bus to avoid a plant shutdown owing to a momentary voltage drop.

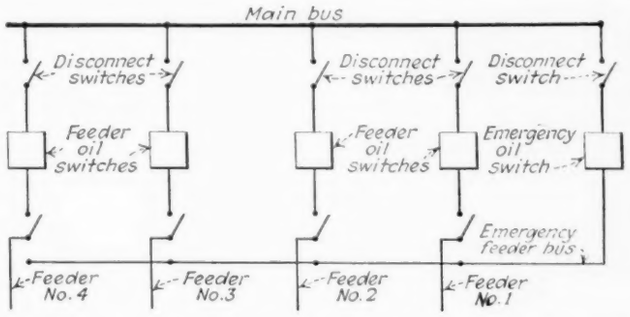


Fig. 5—Emergency feeder bus allows any feed oil switch to be taken out of service for repair

Power feeders should be so arranged as to diversify equipment as much as possible, so that duplicate equipment will be on separate feeders. Where it is justified, because of the size of the plant, an emergency feeder bus should be provided as shown in the diagram, Fig. 5, and at the right in Fig. 9. This permits repair work to be done on any feeder oil switch without taking the feeder out of service. An ammeter should be provided to indicate the total current on the feeders or, where the installation is large, an ammeter should be used on each feeder.

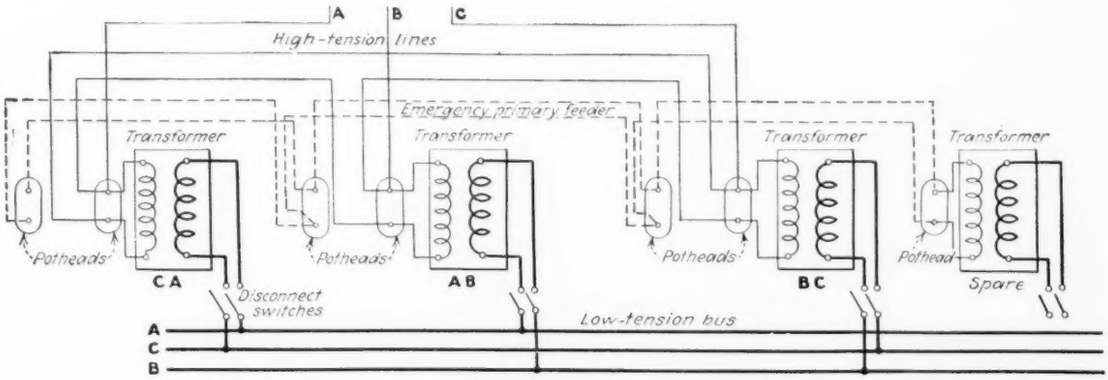


Fig. 4—Diagram of connection that allows a defective transformer to be quickly replaced by a spare

Compressor-Room Machinery

The motors driving the ammonia compressors and in some cases the air compressors, where they are large enough, are driven by slow-speed engine-type synchronous motors. The motor-generator sets for excitation can be operated by high-speed synchronous motors if they are sufficiently large, the size depending somewhat on the power company requirements.

The plant, Fig. 1, is an unusually large one and is cap-

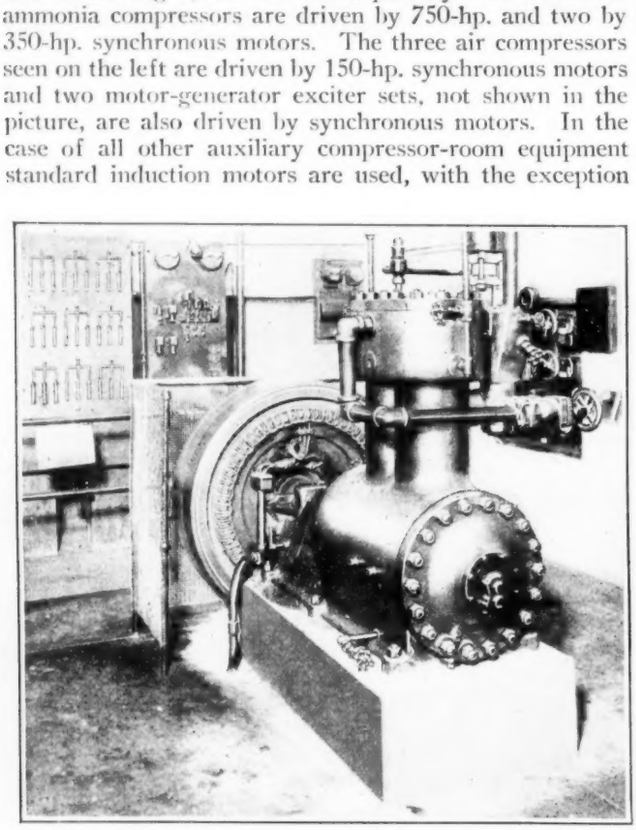
able of making 1,000 tons of ice per day. Three of the ammonia compressors are driven by 750-hp. and two by 350-hp. synchronous motors. The three air compressors seen on the left are driven by 150-hp. synchronous motors and two motor-generator exciter sets, not shown in the picture, are also driven by synchronous motors. In the case of all other auxiliary compressor-room equipment standard induction motors are used, with the exception of the liquid-ammonia pump and triplex pumps; slip-ring motors are provided to furnish the additional starting torque required. The foregoing applies to refrigerating plants in general.

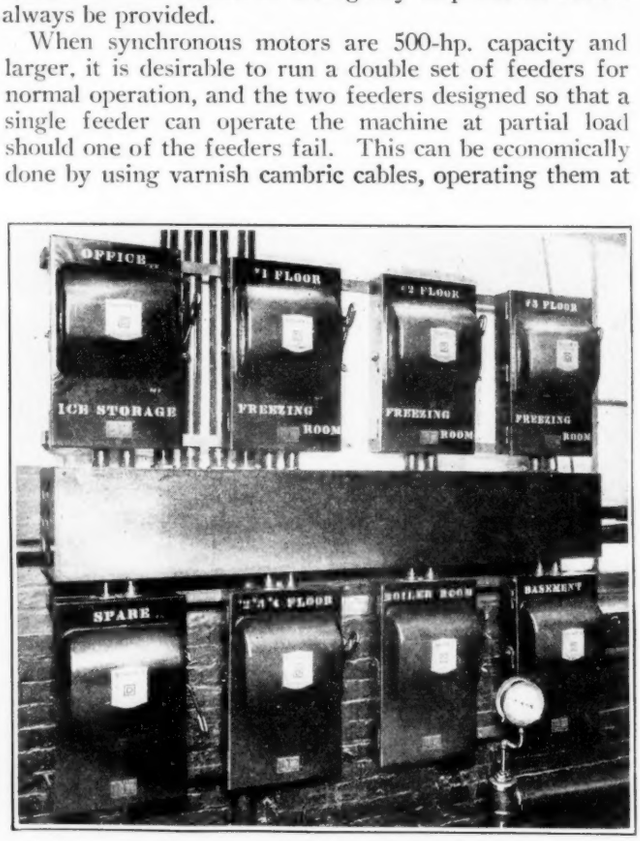
In the plant, Fig. 1, the switchboard is mounted on a gallery at the end of the engine room. The gallery floor also forms the roof of the transformer and switch-rooms. All synchronous motors can be started from the switchboard only, but at each motor an emergency stop button is provided. Wherever the switchboard is remote from the motors such an emergency stop button should always be provided.

When synchronous motors are 500-hp. capacity and larger, it is desirable to run a double set of feeders for normal operation, and the two feeders designed so that a single feeder can operate the machine at partial load should one of the feeders fail. This can be economically done by using varnish cambric cables, operating them at the rubber covered cable rating and using a size larger than necessary.

Duplicate equipment may be provided for excitation in the form of two motor-generator sets, either one being capable of carrying the load. The starting equipment for the exciters should also have the no-voltage release coil connected on the direct-current bus.

In cases where electric trucks are used for delivering ice to the trade, the exciter motor-generator sets are furnished large enough to handle the battery charging





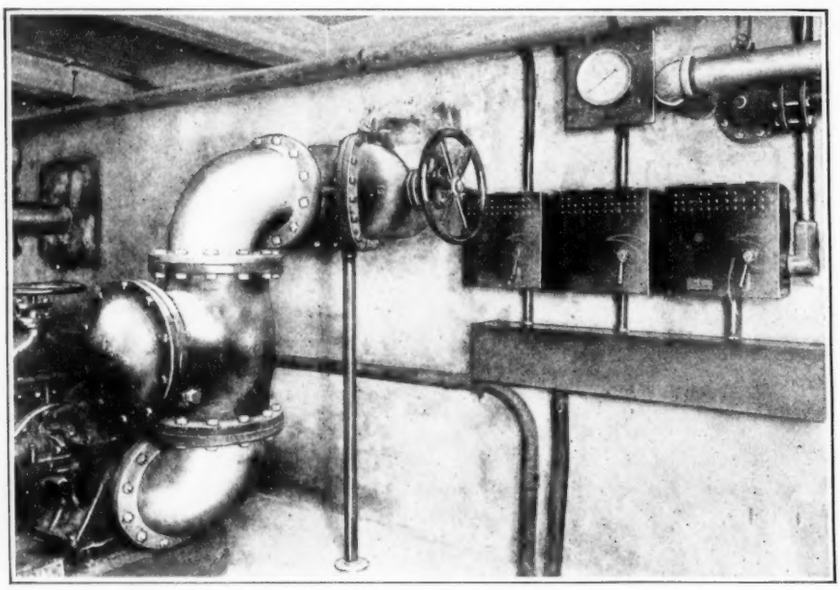


Fig. 6—(Upper left)—Flywheel-type synchronous motor directly connected to small compressor

Fig. 7 — (Upper right) — Safety switches grouped around a junction box

Fig. 8—(Left)—Inclosed-type circuit breakers grouped at a junction box

load. Care must be taken to equip the motor-generator sets and the battery-charging feeder with the proper fuses and relay equipment to avoid unnecessary shutdowns of the exciter set, which, of course, would automatically shut down the synchronous motors.

The synchronous motors previously referred to for driving the ammonia compressors are standard engine-type machines. For compressors of small capacity one manufacturer has developed a flywheel-type synchronous machine which is available in capacities as low as 20 hp. This type of synchronous motor, shown in Fig. 6, is designed with the rotating field outside the stator, a practice that is the reverse of the ordinary engine-type unit.

The feeders for distribution of power to auxiliaries should be so designed as to permit of easy additions to plant capacity and yet retain safety in operation. The use of the ordinary panel board with knife switches inclosed in a cabinet is not to be recommended. Banks of safety switches around a common junction box, as shown in Fig. 7, is a desirable arrangement, not only on account of the cost, but also because it provides a safe neat installation which can be added to without detracting either from safety or appearance.

Instead of safety switches, an inclosed type of circuit breaker can be used and is mounted in the same way, as shown in Fig. 8, where inclosed type of circuit breakers are used to control condenser cooling-water pump motors. As will be noted, the feeder terminal box is located like an insulated bus. With such an installation another motor can be connected to the feeder at any time later, without shutting down the feeder and without introducing a hazard to the workman.

Because of the importance of keeping the auxiliary equipment operating when minor voltage dips occur, magnetic contactors equipped with some form of time-delay release should be used. There should also be provided push-buttons for starting and overload protection.

In the ice-tank room the same rules apply to the feeder distribution as previously outlined. On account of the wet conditions in that room the equipment must be so mounted as to be in the most protected positions. In an old plant that is being remodeled, where water conditions are bad it is best to protect the crane-trolley wires by means of a hood. It is not advisable to operate the cranes at any voltage higher than 220, and where feasible 110 volts should be used. This also applies to the machinery in the ice-storage room, that is, the ice stacking machine, the ice scoring machine and the conveyor. These machines should be wired with lead-covered cable in conduit, and any portable apparatus should be provided with an additional conductor for grounding the frame.

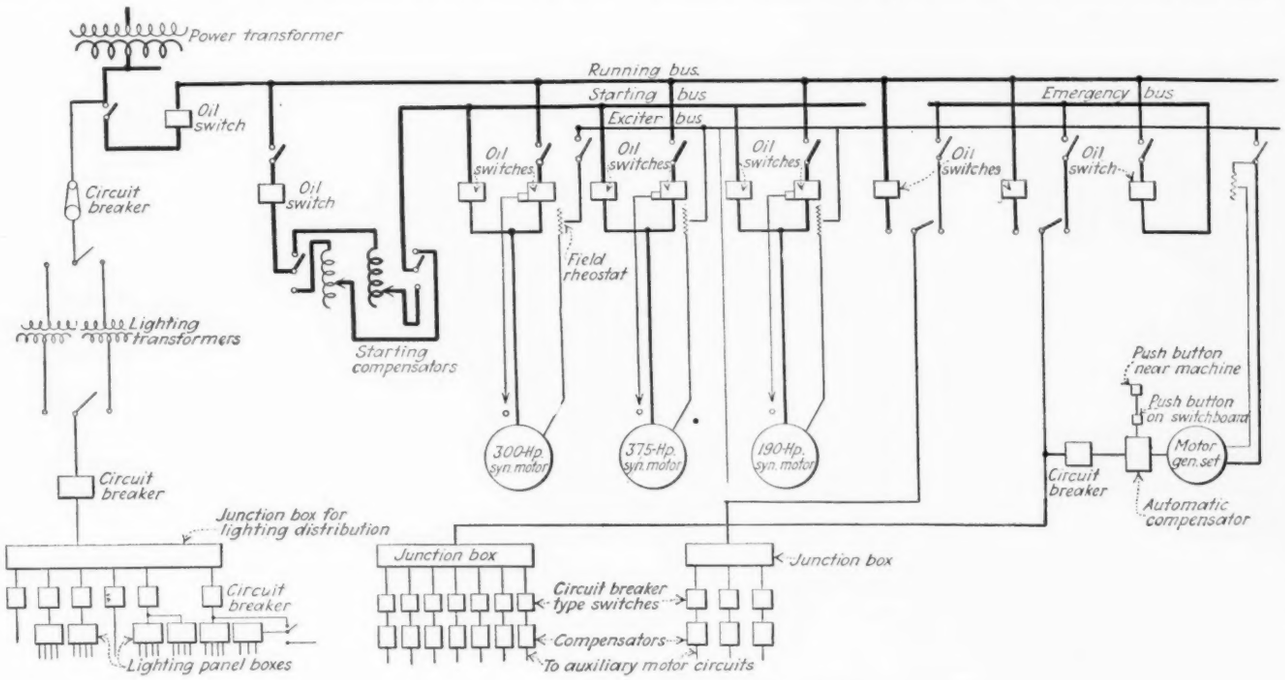


Fig. 9—One-line diagram of plant wiring

On this diagram should be given the size of all wiring and conduits, the names of all switches and the equipment they control and any other information that would be useful to the maintenance men in their work and show what each circuit comprises.

Good lighting is essential to proper operation of an ice plant. For general illumination standard dome reflector sockets of porcelain enameled steel should be used. An illumination intensity of 5 to 6 foot-candles should be used in both the compressor and the ice-tank room with sufficient circuits to allow of economy of operation.

Ordinarily, mounting of the various lamps presents no special problem as ceiling heights are usually normal. In the compressor room, Fig. 1, the method of mounting the lighting fixtures on an unusually high ceiling is shown. The reflectors used were 750-watt units having a special type of disconnecting socket for lowering the unit to the floor for cleaning and lamp replacement.

A one-line diagram, as shown in Fig. 9, should be in every plant to facilitate maintenance and repairs. This should be mounted in a frame on the wall for ready reference. All apparatus in the plant should be painted and plainly marked. In general it can be said, "A clean, well-kept plant always produces ice at the lowest cost per ton."

Fig. 1—Airplane view of Bush Terminal buildings, Brooklyn, N. Y.

New Boiler Plant Supplies

Process and Heating Steam

For Bush Terminal

SOME thirty years ago Irving T. Bush began the construction of terminals along the south waterfront of Brooklyn. This project, designed to locate factories so that both raw materials and finished product could be shipped either by freight or by steamship, has grown steadily until today its industrial pre-eminence is known the world over. The Bush terminals occupy more than 200 acres of developed property. Along the waterfront eight piers, one of them the largest freight pier in the world, project into New York Bay. On this property are 123 warehouses, cold storage buildings, administrative offices, distribution service buildings, and sixteen model loft buildings which are leased in space units to both large and small manufacturers and distributors. There is 5,550,000 sq.ft. of manufacturing facilities, 26,000,000 cu.ft. of storage space, and 1,000,000 cu.ft. of cold storage space.

The Bush company operates 35 miles of railroad spur tracks, between the industrial buildings, warehouses and the car floats which lead to terminals with all great Eastern trunk railroads. Some idea of the size of the buildings, warehouses and piers may be obtained from Fig. 1.

To satisfy the steam requirements of the various industries occupying the loft buildings, two boiler plants have been operated furnishing process steam for the industries and heating steam for the buildings. The Thirty-third Street plant contains eight 4,400-sq.ft. water-tube boilers, fired by underfeed stokers, and seven 3,380-sq.ft. hand-fired boilers. The older plant at Fortieth Street contains six 4,400-sq.ft. boilers all hand fired. The increasing demand for steam due to additional loft buildings and the inefficiency of the older hand-fired boilers has dictated the necessity of constructing a new boiler plant to replace the six old 4,400-sq.ft. boilers in the Fortieth Street plant.

The new plant, located at the foot of Fortieth Street and New York Bay, as shown in Fig. 3, will contain four boilers, each having a heating surface of 10,370 sq.ft. These boilers, of the inclined-water-tube type, are designed for a working pressure of 225 lb. per sq.in. At present, however, they will be operated at only 130 lb. pressure, the higher pressure boilers being installed to take care of any possible future requirements for high-pressure steam that extensions to the terminals might bring. The boilers are arranged in two rows facing a single firing aisle. Fig. 2, a sectional elevation through the plant, shows the boiler settings and layout of other equipment.

Bituminous coal for the plant is received by rail and is dumped directly into track hoppers, from which two apron conveyors carry the coal to either of two 85-ton coal crushers. These crushers are arranged so as to discharge the crushed coal to a bucket elevator that hoists and distributes the coal to a 1,070-ton coal bunker. A

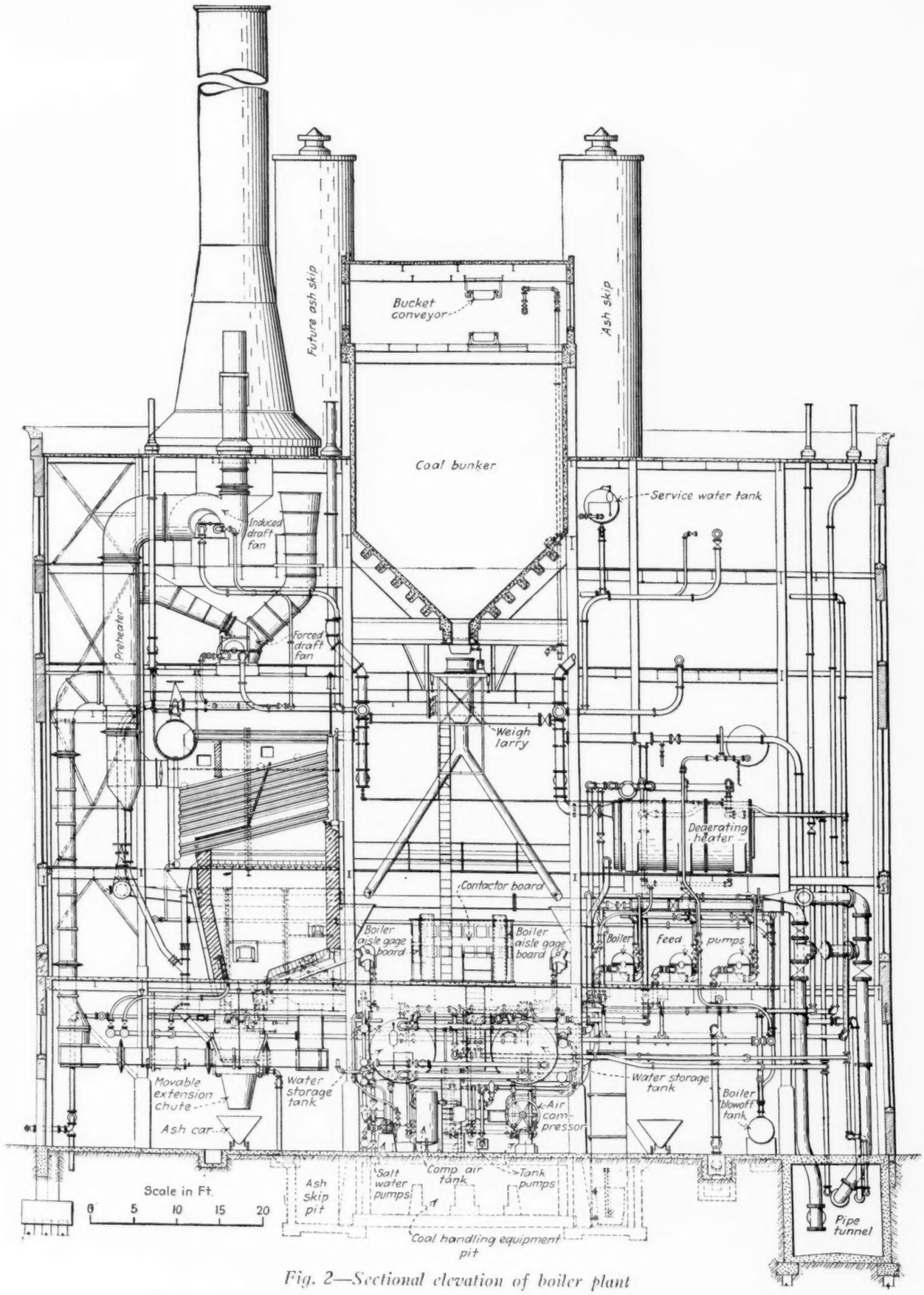


Fig. 2—Sectional elevation of boiler plant

2-ton traveling larry is provided for weighing and distributing the coal from the bunker to the boiler hoppers.

The boilers are fired by eight-retort underfeed stokers that are capable of producing 250 per cent rating. The stokers are driven by turbines direct connected through reducing gears. Double-roll clinker grinders are driven from the stoker shaft. This turbine drive takes up less room than a motor drive and permits close speed control of the stoker. It is particularly adaptable to the application of automatic combustion control, which is to be installed as soon as the plant is in operation.

Ash is dumped from ash hoppers under each boiler through hydraulically operated gates into narrow-gage cars. At the end of each boiler battery is a skip hoist to which the cars deliver the ash refuse. The hoists dump the ash into a bunker where it is stored until removed in motor trucks.

Air for combustion is supplied by turbine-driven forced-draft fans of 22,000 c.f.m. capacity through plate-type air preheaters. The preheaters have 13,800 sq.ft. of effective heating surface and are designed to heat the air to 458 deg. F. and to reduce the temperature of the flue gas to 321 deg. F. when the boilers are operated at 250 per cent rating.

One 30,000-c.f.m. turbine-driven induced-draft fan per boiler delivers the flue gas to a steel brick-lined stack. The two stacks are 143 ft. high above the boiler room roof and each serves two boilers.

Individual boiler control boards are provided for each boiler. They are installed in front of and facing each boiler so that the fireman can see the instruments on the board while working on the stoker. Each board contains a steam-flow meter, steam and feed-water pressure gages, a multipointer draft gage, and two thermometers that record the air and gas temperatures in and out of the air preheater. On a separate pedestal alongside of the gage boards is a CO_2 recorder.

During the winter months all the condensate from the building heating system is returned. Of the process steam used by the tenants only about 50 per cent is returned. The remaining half of the process steam condensate is lost to the sewer because the processes in which the steam is used contaminates it so as to make it unusable for boiler feed water.

These returns are collected in four 6,600-gal. storage tanks in the boiler plant basement. City-water makeup is admitted through float valves installed on two of the tanks. Emergency city-water connections are made to the deaërator and to the suction header of the boiler feed pumps. This piping arrangement allows the deaërator to be bypassed when necessary to make repairs.

Three pumps are installed for pumping the water from the tanks to the deaërating heater that is located above the boiler room operating floor. From the heater the water flows by gravity to three turbine-driven 500-g.p.m. boiler feed pumps that deliver the feed water to the boilers through feed water regulating valves.

Steam for heating the feed water is supplied by the exhaust from the steam-driven auxiliaries already mentioned and also from an engine-driven compressor of 246 cu.ft. of free air per minute capacity.

A pipe line from the low-pressure steam system of one of the loft buildings is connected to the auxiliary exhaust steam header in the plant. Exhaust steam supplied by the auxiliaries in excess of the deaërating heater demand is used in the low-pressure system in the loft building. This arrangement makes a simple and flexible heat balance.

In addition to the individual boiler gage boards there is a main control board on the boiler room floor containing the following instruments: Flow meters and pressure gages on the two 16-in. diameter steam mains through which the steam generated is distributed to the terminal buildings, and on the low-pressure steam line from the auxiliary exhaust steam header, long-distance thermometers for recording the feed water and storage water temperatures, and gages for indicating city water, feed water, exhaust header and blowoff tank pressures.

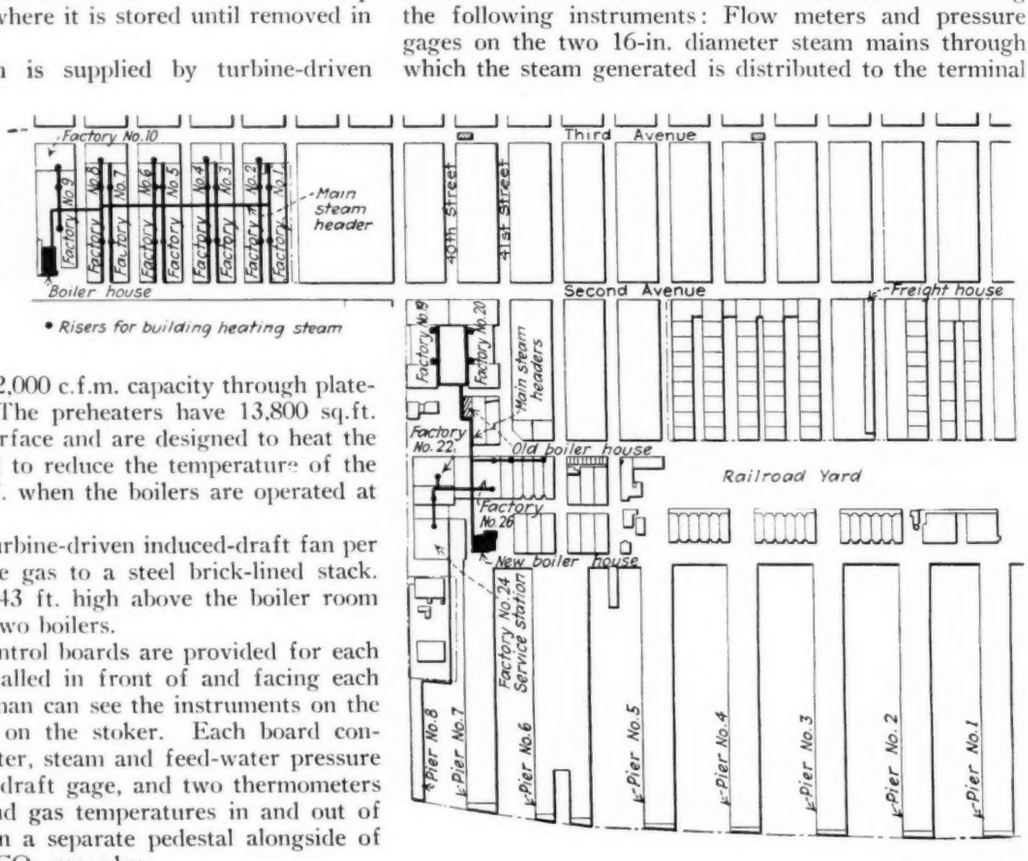


Fig. 3—Plan of terminal buildings showing main steam distribution headers

Provision has been made for the future; extension of the plant and the foundations for the next section of boilers are now being laid.

The distribution of steam to the various factory buildings is accomplished in two separate systems. Steam from the Thirty-third Street boiler plant is distributed to factory buildings one to ten. A 15-in. line carries the steam from the plant and is reduced at intervals to 10 in. and 8 in. High-pressure drips are returned in a 4-in. pipe line and low pressure drips in a 6-in. line.

The new boiler plant supplies the remainder of the factory buildings as shown in the diagram, Fig. 3. Steam leaves the plant in two 16-in. lines that are reduced in

size as the distance from the boiler room increases. A 4-in. and a 6-in. line return the high- and low-pressure steam drip.

The main steam lines shown in Fig. 2 and the returns are laid in pipe tunnels and in the basements of the factories. These tunnels, which in the Thirty-third Street system are 11 ft. wide by 6 ft. high, and in the system supplied by the new boiler plant are 9½ ft. wide by 8 ft. high, are amply large and greatly facilitate maintenance work on the steam headers.

Branches from these mains supply steam to the various tenants and for the building heating system. Steam for the tenants must, of course, be metered in order that proper charges for steam use can be made. The meters for recording the process steam flow are located in the tenant's own space. High-pressure steam is supplied to the tenant, who installs the reducing valve equipment necessary for reducing the pressure to meet his requirements.

A riser carries high-pressure steam for building heating from the basement to the top floor of the factory building, where it is metered and its pressure reduced to between one-half and two pounds per square inch, depending on heating requirements. The location of these risers is shown in Fig. 3. From this point branch lines feed downcomers that supply steam to the radiators, which are all of the pipe-coil type and equipped with thermostatic traps. The pipe coils are arranged along the building walls under the windows and total 522,300 sq.ft. of direct radiation.

The heating system returns for each building are collected in receiver tanks in the building basement from which a vacuum pump removes them and pumps them back to the boiler house. The vacuum pump also removes all the air from the system and maintains a vacuum of between 5 and 10 in. of mercury.

Careful record is kept of all the steam used. The table shows the pounds of steam generated during the year 1926 and its division among the various uses. The heating steam used during a season averages about 92,000 lb. per 1,000 sq.ft. of floor space heated, or about 7,500 lb. per 1,000 cu.ft. of building volume. It is interesting that the steam requirements for building heating are greater than the amount of steam distributed to tenants.

STEAM DISTRIBUTION, 1926

Pounds steam generated	1,546,584,000
Pounds steam sold to tenants	440,360,157
Pounds steam to pump water from wells	48,021,484
Pounds steam to pump water for toilets	5,546,296
Pounds steam for heating	502,255,224
Pounds steam for auxiliaries	154,658,400
Pounds steam account miscellaneous distribution and losses	395,742,439

Steam for heating is metered at 34 stations in the various buildings. The flow through these meters is recorded twice daily together with the outside temperature and wind condition. This record forms the basis for regulating the heating system. For any weather conditions the necessary steam flow is known from the previous record, and the flow through the heating system meters is adjusted accordingly. To accomplish this control an operator visits each of the 34 stations twice daily, adjusting the steam flow to the required amount.

The difficulty of maintaining close regulation by this system has been realized, and a method of remote control has been developed. It consists of a pressure element arranged to operate a motor-operated valve so as to maintain a constant pressure on the system. This pressure element can be set by remote control to maintain any desired constant steam pressure. By correlating the steam pressure and steam flow, the desired regulation can be obtained. An experimental installation of this control has been in operation during the last two years, and it has given such satisfaction that this system of remote control has been installed in the recent building additons.

Power acknowledges the assistance and co-operation of Stevens & Wood, Inc., designers and engineers for the new boiler plant, and of A. Helwig, mechanical engineer, Bush Terminal Company, in the preparation of this article.

Constituents of Refractory Materials

THE value of a chemical analysis of refractory material is not appreciated as it should be, mainly on account of the difficulty of interpreting the results. A brief description of the material contained in the average fireclay may help the engineer to whom refractory analyses are presented to understand its meaning better.

Silica and lime are the major constituents of a silica brick, but in clays or clay refractories there are many more constituents to be determined, such as silica, alumina, iron oxide, titania, lime, magnesia and alkalies.

Clean, white sand is nearly pure silica, as is quartz or ganister. It is present in most rocks and minerals, being the most common constituent on the earth's surface. Its melting point is high (3,200 deg. F.), and it is a principal constituent of clay.

Alumina is second to silica in its abundance on the earth's surface, but it seldom occurs as a pure material. It is usually in combination with other materials forming rocks and minerals, such as clay which is principally silica and alumina. Emery is fairly pure alumina. The melting point of alumina is high, 3,700 deg. F.

Ordinary red iron ore is iron oxide, as is the rust that forms on iron. The oxygen of the air combines in a chemical way with iron to form rust. Different oxides form, depending on the amount of oxygen that combines with the iron. Any of these oxides act as a flux with refractory materials, lowering their melting points. Iron is probably the most serious flux and should be kept low in any good refractory. Titania is not very common in nature and is usually present in small amounts in clays, increasing in percentage as alumina increases, so that diaspores contain as high as 5 per cent.

Lime and magnesia are essentially the same in their properties. Lime is a common material and is made by heating limestone, while magnesia is made by heating or calcining magnesia. Both are very refractory when alone, but if mixed with clays they act as serious fluxes.

Soda and potash are the materials called alkalies. Ordinary lye is soda or sodium oxide. These materials are active fluxes with any refractory. They melt at a red heat and form a vapor at high temperatures. The oxides of iron probably exert the most serious detrimental effect on the properties of refractories. The alkalies are next in importance, followed by lime and magnesia. Any one of these fluxes present in silica and alumina would not render the interpretation so difficult, but the presence of several fluxing agents usually makes the estimation troublesome to one not familiar with the material.

Process Steam and Power in PULP AND PAPER *Mills*

With a discussion of the important heat wastes and methods used to minimize them

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BRIEFLY, the manufacture of paper consists of chipping and cooking logs of spruce, fir, hemlock, etc., with chemicals and of grinding other logs by means of a stone. The two products are freed from knots, slivers, etc., and are run onto a running screen of a paper machine where a unit part is felted in 3 seconds, pressed in 2 seconds, dried by steam heat in 40 seconds, quickly calendered and wound up into rolls ready for the printer.

Every ton of newsprint manufactured requires from 1,000 to 1,500 lb. of coal and from 10,000 to 13,000 lb. of steam. The Canadian Department of Mines reports the average coal and steam consumption of seven leading newsprint mills in Canada as 1,400 lb. and 10,700 lb. respectively.

Nearly 15 per cent of the total cost of making paper is represented in the cost of coal and the steam generated with it. If the cost of wood used as a raw material was disregarded, the steam cost would represent from 30 to 40 per cent of the cost of conversion of the raw materials into paper. Steam constitutes the second highest single item of cost in the industry.

A survey was made recently to learn how industrial power plant boilers are fired. The results showed that hand firing is still used in one-half of these plants; 35 per cent use automatic stokers. It is interesting to note how the firing practice in paper mills compares with those of industrial plants in general.

	Pulp and Paper Industries, Per Cent	All Industries, Per Cent
Hand grates	33.0	50.0
Hand stoker	9.5	12.5
Automatic stoker	62.0	35.0
Oil and gas burners	13.5	15.5
Pulverized coal	3.8	2.5

Owing to there being several methods used in single plants in many cases, the percentages do not add up to 100. It will be interesting to watch the developments in boiler firing practice as time goes on. The use of oil and gas burners will, of course, be governed largely by the availability and the cost of the fuel used. Automatic stokers, coal pulverizers and hand stokers will look largely to the 33 per cent of existing hand grates, as well as to new installations, but there will doubtless be a number of changes in the proportions of each method as new developments are made.

The coal used in the paper industry is practically all burned under the boilers for producing process steam; but little, if any, in many of the mills is converted into electric energy, since the mills are often located on a waterway contiguous to a water power or within easy transmission distance of a hydro-electric plant. Many of the larger mills have their own hydro-electric plants, and a development of these on a scale commensurate with the future growth of the industry has resulted in some cases, in the development of a large excess of power which cannot be economically disposed of for power in the neighborhood and must therefore be utilized inefficiently or else wasted.

This situation has led to the installation, in some mills, of boilers generating steam from electric energy, aggregating many thousand horsepower. For electric steam generators to play an important part in the paper industry, electric energy must be available at not more than $10 per kilowatt-year in order to equal coal costing $6 per ton. Ten dollars is below the profitable selling cost of power, and it will be disposed of at this price only when there is no other demand for the surplus power. As soon as a market is created, the price of electrical energy will mount rapidly and electric generated steam will have to make way for coal generated steam. Pulp and paper mills, however, are using the electric steam generator to "iron out" their load curves. Many of them have surplus electrical energy throughout the day, and on Sundays and holidays, that can be turned to good account.

Electric steam boilers are already operating in the following mills:

Wayagamac Pulp & Paper Co., Three Rivers, Quebec	One	20,000-kw.
Laurentide Co., Grand Mere, Quebec	Two	25,000-kw.
St. Maurice Lumber Co., Three Rivers, Quebec	One	12,000-kw.
International Paper Co., Niagara Falls, N. Y.	One	18,000-kw.
Price Brothers	One	7,000-kw.
Ontario Paper Co., Thorold, Ont.	One	3,000-kw.
Oxford Paper Co., Rumford, Me.	One	16,000-kw.
Washington Pulp & Paper Co., Port Angeles, Wash.	One	5,000-kw.
Brown Company, Berlin, N. H.	One	18,000-kw.

There are very few steps in the process of making paper that do not require steam to some extent. Each pound of paper requires from 4 to 7 lb. of steam for preparation. Approximately 0.044 hp. of mechanical energy is needed to produce a pound of paper.

The trend in modern paper-mill steam-plant practice is to generate steam at high temperatures and pressures. Many data on this subject have been reported in technical publications by A. G. Darling, of the General Electric Company. While it is true that equipment for this work

costs more, it is true on the other hand that the economies from the steam-using equipment generally warrant the additional expenditure. The paper industry has installed a greater percentage of high-pressure turbines than any other industry. It is followed in this respect by the copper refining and petroleum refining industries. Following are some of the more recent installations of high pressure turbines in the paper industry:

Company	Turbine Capacity, Kw.	Initial Pressure Lb. per Sq.In.	Total Temp. Steam	Bleeder Steam Lb. per Sq.In.
W. Va. Pulp & Paper Co., Covington, Va	1–4,000	400	635	150
Paul A. Sorg Paper Co., Middletown, O	2–5,000	375	692	50 and 20
International Paper Co., Livermore Falls, Me	1–3,000	400	608	...
St. Lawrence Paper Mill, Three Rivers, Que	6–500	200	480	...
Eagle Paper Co., Joliet, Ill	1–300	300	622	15
Consolidated Water Power & Paper Co., Port Arthur, Ont	1–2,500	350	686	110 and 25
Consolidated Water Power & Paper Co., Wisc. Rapids, Wisc	1–5,000	350	686	125 and 25
Chesapeake Corporation, Westpoint, Va	1–1,500	425	554	...

Steam produced at 250 lb. gage and 200 deg. superheat represents a large amount of available energy inasmuch as the pressure of the steam supplied to the pulp digesters seldom exceeds 100 lb. gage. This permits the use of a bleeder turbine and non-condensing engines to convert part of the pressure of the steam into mechanical and electrical energy and to exhaust the remaining steam into the process steam mains.

Prior to the use of high-pressure boilers in paper mills, it was necessary to deliver the live steam directly to the pulp digesters and the paper driers, as the pressures generated seldom exceeded 150 lb. and the pressure requirements for sulphite pulp digesters were in the range of 80 to 100 lb.

To illustrate in a simple but satisfactory way how steam is distributed in a paper mill, consider the requirements of a typical newsprint mill, since the tonnage of this class of paper far exceeds all the other types. Newsprint usually is composed of groundwood and sulphite pulp in proportions of 80 per cent and 20 per cent respectively. For convenience we will assume that this mill produces 100 tons of newsprint each day.

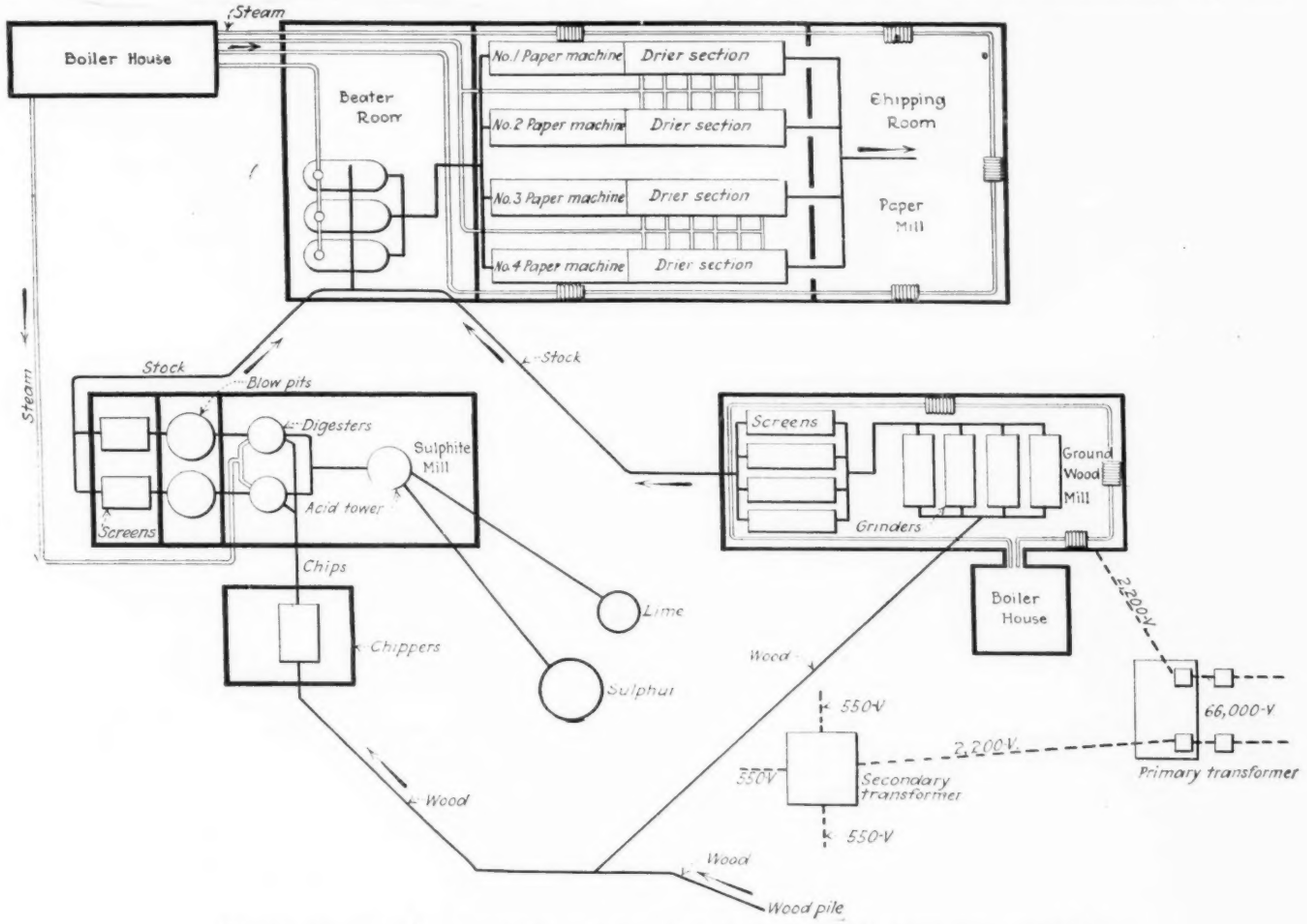


Fig. 1—Layout of a newsprint mill showing distribution of steam and material

The chart, Fig. 1, showing the distribution of steam for process purposes includes the most important points of steam application for this class of work. In actual plant operation there are many minor uses for steam such as in making rosin size and cleaning fourdrinier wires.

In most newsprint mills the pressures used for the various phases of process work are as follows: For cooking or digesting, 80 to 100 lb. gage; beating, 20 lb. gage; drying, 20 lb. gage; and heating 20 lb. gage.

Steam consumption for these services has been reported as follows:

Process	Average Lb. Steam per Day	—Lb. Steam per Hour— Ave.	Max.	Min.
Cooking or digesting	135,000	5,630	19,700	3,840
Beating	20,000	834	2,000	.....
Drying	775,000	32,300	40,300	16,000
Heating	155,000	6,450	19,600	.....
Total	1,085,000	42,214	81,600	19,840

The steam requirements for process work and for heating range from 4,000 to 20,000 lb. per hour approximately, according to the time of year and the requirements of the process.

The figures on which Fig. 2 is based, are as follows: steam requirements for cooking or digesting, 0.6 to 0.8 lb. per lb. paper; for beating, approximately 0.6 lb.; for drying, 3.0 to 4.8; for heating, 0.3 to 1.3; for all these purposes, 4.5 to 7.5 lb. steam per pound paper.

If we assume that the steam is being produced at 150

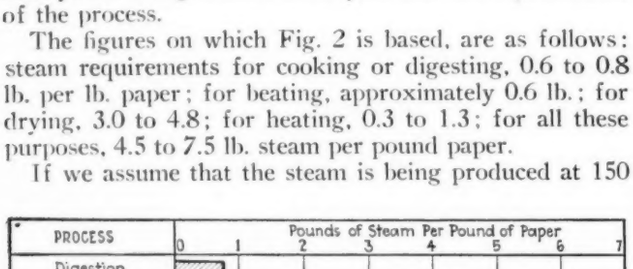


Fig. 2—Distribution of process steam in paper manufacture

lb. gage, it is evident that the pressure differential of 50 to 70 lb. between the steam pressures at the boiler and the steam requirement of the digesters is insufficient to justify its use in developing mechanical energy. There is, however, much available energy represented in the differential between the boiler pressure of 150 lb. and the drier, beater and heater pressure requirement of 20 lb. The amounts vary from 60,000 to 15,000 lb. per hour.

There are various methods of utilizing the energy in this steam before it is used for drying, beating and heating.

Under the conditions that we have assumed, the average amount of process steam will develop approximately 750 kw. The groundwood and grinder load being supplied from hydro-electric power, there is left a residue of 1,050 kw. to be generated by steam passing through the entire turbine to the condenser at a very economical rate.

The mechanical power requirement of this 100-ton newsprint mill for process work is about 9,000 hp., which is distributed in the following manner:

	Hp.
Sulphate Mill:	
Wood room	125
Screens, pumps, etc.	150
Groundwood Mill:	
Wood room	100
Grinder room	5,700
Paper Mill:	
Beaters, jordans, pumps, paper machine, etc.	1,500
Finishing room	50
Machine shop	65
Supercalenders	1,310

At this point it may be interesting to observe the steam records of a mill in Wisconsin having a rate capacity of 100 tons of paper per 24-hour day. Careful records are maintained showing the tons of coal used. All the coal is weighed into a stoker, and the weigh-ticket is punched and dropped into the slot representing that particular boiler. In this manner it is possible to obtain the summation of the coal weights supplied to each boiler over any period of time by collecting and totaling the weigh-tickets.

To measure the quantity of steam generated by each individual boiler and distributed to the process points, flow meters are installed. It is thereby possible to obtain a record produced by the boilers and the steam consumed by the mill. The difference is the amount of steam used in the boiler plant, or 8 per cent of the total production. These steam records for a single day in December are shown in the following tabulation:

STEAM PRODUCTION

	Pound of Coal Consumed	Pounds of Steam Generated	Hours of Operation	Per Cent Rating	Lb. Steam per Lb. Coal
Boiler No. 1	41,400	355,500	24	164	8.60
Boiler No. 2	36,500	627,000	24	...	Refuse
Boiler No. 3	57,800	500,100	24	174	8.65
Boiler No. 4	60,300	519,500	24	181	8.63
Boiler No. 5	55,300	491,200	24	227	8.87
Boiler No. 6	7,600	66,500	4	184	8.69
Boiler No. 7	43,300	377,100	24	174	8.71
Total	302,290	2,936,000	148	184	8.71

Water—3,480,000 lb. Atmospheric temperature—high, 35; low, 32.

STEAM DISTRIBUTION

	Pounds Steam Consumed	Tons Produced	Pounds Steam, per Ton
Digester No. 1	89,900	11	8,170
Digester No. 2	112,000	14	8,000
Digester No. 3	123,100	18	6,830
Total	325,000	43	7,560
Machine No. 1	39,200	2,340	16,700
Machine No. 2	139,500	15,715	8,800
Machine No. 3	171,000	18,793	9,090
Machine No. 4	114,100	10,601	10,750
Machine No. 5	91,200	7,574	12,030
Machine No. 6	191,000	36,245	5,280
Total	746,000	91,268	8,180

Some idea of the cost of a pulp and paper mill may be obtained in the figures for the Powell River Company mill published in October, 1926, in the Powell River *Digester*. Two 234-in. newsprint machines were added to the plant. To supply paper for these machines it was

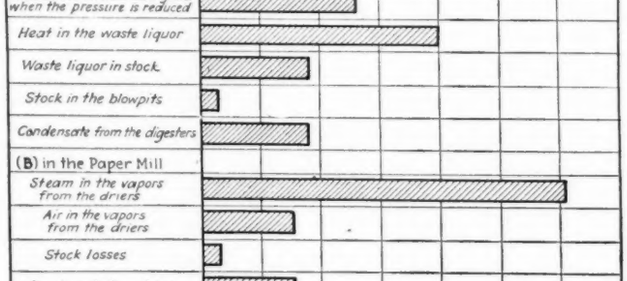


Fig. 3—Analysis of heat losses in a paper mill

necessary to enlarge the pulp mills, boiler house, generating plant, etc. A total cost of $8,000,000 was involved in the undertaking. This was apportioned as follows:

Machine room and finishing room	$2,700,000
Sawmill and woodroom	1,200,000
Boiler house	900,000
Hydraulic development	675,000
Generating plant	325,000
Grinder room, screenroom, waterwheels, etc.	720,000
Sulphite plant, acid plant, digesters and screenroom	570,000
Warf and tramways	300,000
Machine shop	80,000
Miscellaneous mill improvements	80,000
Townsite	500,000
Total	$8,000,000

Heat is employed in the pulp and paper mill under three sets of conditions, if we assume a basis of temperature differentials:

1. Heat furnished at temperatures between 300 and 400 deg. C. This range includes the heat in the steam used only for operating power producing apparatus.

2. Heat furnished at the temperature range of 130

to 220 deg. C. This heat is found in the steam exhaust from the power producers and is used for heating and digesting purposes.

3. Heat released between 100 and 50 deg. C. This heat comes from the steam in the above mentioned stages, which has been employed for drying and digestion and which in the manufacturing processes is carried away into the form of vapors, gases, air, waste liquors, etc. This heat, at the present time goes largely to waste.

Waste heat in a pulp and paper mill includes the following:

(*a*) Heat contained in mixtures of air and steam from pulp and paper machine driers.

(*b*) Heat from the digester relief gases.

(*c*) Heat in the waste gases from the digesters and cookers and in the waste liquors.

(*d*) Heat in the various condensates.

(*e*) Heat in flue gases from the boilers.

In order to visualize the magnitude of this waste, Fig. 3 shows the important items of heat loss in the pulp and paper mill. For convenience these losses are expressed in percentage of the total heat losses exclusive of the boiler house losses, which are losses common to all industries using steam for power and process work.

Details of Heat Wastes

The vapors from the pulp and paper driers (item *a*) are a mixture of air and water vapor. These vapors contain the entire amount of water evaporated from the pulp and paper webs. The amount of heat so entrained is considerable. The heat contained in the pulp is relatively slight and cannot be used, but the heat in the condensate is utilized in most modern mills. The quantity of heat used for heating up the air is considerable, but many mills do not make a practice of recovering the heat contained in the vapors given off by the paper web as it is dried. Sixty-five per cent of the heat lost by the driers is present in this moisture. At present it is difficult to utilize this, inasmuch as its temperature is only about 50 deg. C. or less. Engineers have endeavored to use this heat for warming the incoming air. To do this the moisture in the waste vapors are condensed and the incoming air is passed through the condensers to take up the heat of vaporization contained therein. This warm air is then used for heating the machine room and for removing the moisture from the paper.

In some instances the warm air is used for drying the drier felts. This has made it possible to operate without felt driers. The apparatus needs to be quite large to provide for the large quantities of steam and air to be handled and to take the small temperature into proper account. The practice in most mills is to cover the drier part of the machine with a hood made of asbestos tile, so that practically none of the moisture can pass into the machine room. From one to three large diameter ducts lead from the hood to the air economizer.

In the use of condensers for the mixed steam vapors and air, the entire quantity of heat is saved and is used for direct heating of the incoming air and, by radiation, for heating up the bottom of the drying cylinders. In suction installations that bring the vapors at their highest possible temperature into the condenser, mixed with as little air as possible, large quantities of fresh air may be warmed. Efficient suction installations are also advantageous for machine operation in that they increase the productive capacity of the machines. In addition, there is obtained a quantity of condensate which corresponds to the quantity of condensed steam. This condensate cannot be used without further treatment as boiler feed water, for it may contain a certain amount of acid and is also contaminated with other impurities.

Items (*b*) and (*c*) refer to the heat values that are allowed to go to waste in the operation of pulp digesters. These include the heat that is liberated when the pressure is reduced in the operation of pulp digesters, the heat that goes to waste in the waste liquors, that which goes to waste in the hot pulp and in the liquor that adheres to the pulp, the heat that is lost in the water gases, and finally that which is lost in the condensate from Mitscherlich digesters.

When the pulp has been thoroughly cooked in the digester, the pressure in the digester is reduced and the pulp is discharged into pits. Heat is liberated when the digested pulp or the waste liquor is permitted to come in contact with the air after having come from the higher pressure conditions that exist within the interior. The heat released by pressure reduction is first seen to be set free at the point when the pressure is reduced in the digester, and the end temperature in it corresponds to the saturation temperature of the steam. From this point on, the digester acts like a Ruths steam accumulator, as during the pressure reduction the heat of the liquid is released. This has the effect of automatically and spontaneously generating steam from the contents of the digester.

It has been calculated that for every kilogram of chemical pulp made there are 550 kilogram-calories of heat contained in useful form in the waste liquor. In plants where this liquor is evaporated, calcined or fermented, and in which the conservation of heat is of paramount importance and is a complex problem, provision is often made for utilizing the heat content of the liquors and thereby eliminating the necessity of supplying external heat later.

Heat Recovery from Cooling Water

A large amount of heat recovered in the cooling water coming from the relief gas coolers is derived from the heat in the relief liquor and the heat of vaporization in the steam evolved on reduction of the pressure. While the gas that is led away from the digester contains at all times a little sulphur dioxide in admixture with water and steam, it is possible to consider the heat recoverable from each of these constituents. It has been found that for every kilogram of pulp made in the digester there will be one kilogram-calorie of heat released in the sulphur dioxide gas.

Referring to item (*d*) the heat content of the various condensates from the manufacture of pulp and paper is utilized to a large extent by adding them to the boiler feed water supply. When this is done, care must be exercised to insure their freedom from acids.

The subject of waste heat recovery in paper mills would not be complete without some mention of the waste heat contained in the flue gases from the boiler operation. The heat in the flue gas is considerable, but it is quite true that it has been less put to useful purpose than that recovered from other parts of the paper-making plant. In normal operations the flue gases from the boilers have sufficient heat in themselves to raise the temperature of the feed water from 40 or 50 deg. C. to the feed temperature. In addition to heating the feed

water, the flue gases may also be used to preheat the air.

The paper and pulp industry in the United States ranks fourth in amount of installed horsepower, first in amount of power installed in proportion to capital invested in the industry and first in power per employee, namely, 16.3 hp. In consumption of power the industry ranks second.

There are many kinds of papers manufactured, and to produce each variety the technic of operation requires the use of varying amounts of equipment under such conditions that much or little horsepower is used.

In a well designed newsprint mill, for example, the groundwood may be made with a consumption of 80 hp. per ton. In screening and preparing the groundwood stock for the paper machines, about 10 hp. per ton is required. Since newsprint is usually composed of groundwood and sulphite pulp in a ratio of three parts to one, a ton of newsprint requires about 1,740 hp.-hr., or 72.5 hp. per ton.

In an actual up-to-date newsprint mill having four paper machines, each of approximately 100 tons per day, the groundwood mill uses seven 2,400-hp. synchronous motors for driving the grinders. Each motor drives two grindstones that convert 4-ft. logs to pulp. The number of motors that are required for driving pumps is in itself a considerable item, inasmuch as the dilution of the pulp finally reaches a condition wherein there are 200 parts of water to each part of wood fiber. For each ton of pulp being pumped there would be 200 tons of water. In this particular mill 70 direct-motor-connected centrifugal pumps are used. The motors used have an aggregate capacity of more than 4,000 hp.

The four paper machines are made up of sectional units, each with micrometrical relations with its adjacent units. Each section is driven by a direct-current motor adjustably tied in as to speed with all the other motors on the machine. A 500-kw. direct-current turbine-generator runs each machine with steam that is thereafter used in the driers. The turbines act as reducing valves, incidentally extracting power but permitting 88 per cent of the heat content of the steam to pass on to the driers. Power is received at the mill at 66,000 volts, three-phase and 60 cycles, and is stepped down to 2,200 volts for the grinder motors. The latter voltage is stepped down to 550 volts in a secondary transformer house for general distribution throughout the mill and yards.

The pulp and paper industry with an installed primary horsepower of 1,950,000 in the United States has 20,100 motors, one per cent of all the motors used in industry, aggregating 678,000 hp. The following data report all the services for which motors are used in the mill mentioned in the last paragraph:

MOTORS IN THE WOOD PREPARING PLANT

Service	Number	Hp.	Type
Log haul, 3 saws and barker	1	100	Squirrel-cage
Conveyor (saws to barker)	1	25	Wound-rotor
Three barking drums	3	150	Wound-rotor
Conveyor return logs to barkers	1	10	Squirrel-cage
Conveyor (for bark)	1	25	Squirrel-cage
Conveyor (logs to yard conveyor)	1	10	Squirrel-cage
Conveyor (knife barker to yd. conveyor)	1	25	Squirrel-cage
Conveyor (bark and sawdust to boiler house)	1	15	Squirrel-cage
Saw sharpener	1	3	Squirrel-cage

MOTOR DRIVES IN PUMPHOUSE

Service	Number	Hp.	Type
2—Fire pumps, 10 in., 2,000 g.p.m.	2	200	Squirrel-cage
2—20-in. vertical, 10,000 g.p.m. (river to filter)	2	125	Squirrel-cage
1—16-in. vertical, 6,000 g.p.m. (river to filter)	1	75	Squirrel-cage
1—10 in., 1,800 g.p.m. (river to mill)	1	100	Squirrel-cage
2—18 in., 10,000 g.p.m. (filters to mill)	2	400	Wound-rotor
1—10 in., 4,000 g.p.m. (filters to mill)	1	200	Squirrel-cage
1—Filter washer and air pump	1	30	Squirrel-cage
Screen washer	1	7.5	Squirrel-cage

MOTOR DRIVES IN THE CHIPPER BUILDING

Service	Number	Hp.	Type
Washing drum	1	50	Wound-rotor
Knife barker	1	50	Squirrel-cage
Conveyors to chippers	1	25	Squirrel-cage
Two chippers	2	125	Wound-rotor
Two chipper screens	1	50	Squirrel-cage
Rechipper, blower and log splitter	1	25	Squirrel-cage
Chipper knife grinder	1	3	Squirrel-cage

MOTORS IN DIGESTER AND ACID BUILDING

Service	Number	Hp.	Type
Chip conveyors from chipper building	2	10	Squirrel-cage
Chip elevator to chip bin	1	35	Wound-rotor
Chip conveyor over chip bin	1	15	Squirrel-cage
Rotary sulphur burners	2	10	Squirrel-cage
Gas blower to acid towers	1	10	Wound-rotor
2½-in. pump, 250 g.p.m. (water to acid towers)	1	15	Squirrel-cage
2½-in. pump, 250 g.p.m. (acid to storage)	2	7.5	Squirrel-cage
8-in. pump, 1,600 g.p.m. (acid to digester)	2	40	Squirrel-cage
Acid tower elevator	1	10	Wound-rotor
Digester building elevator	1	10	Wound-rotor
Ventilating fans	3	5	Squirrel-cage

MOTORS IN SULPHITE SCREENROOM

Service	Number	Hp.	Type
10-in. pump, 1,700 g.p.m. (white water to pits)	1	100	Squirrel-cage
Agitator blow pit soft stock tank	1	25	Squirrel-cage
Knotter screen	1	5	Squirrel cage
3 - First screens and 1 second screen	1	150	Squirrel-cage
5 in. pump, 500 g.p.m. (white water to screens)	1	40	Squirrel-cage
10-in. pump, 2,500 g.p.m. (white water to screens)	1	42	Squirrel-cage
10-in. pump, 3,865 g.p.m. (stock-screens to washers)	1	40	Squirrel-cage
3-in. pump, 300 g.p.m. (hp. showers to washers)	1	25	Squirrel-cage
4—Sulphite stock washers (4 drums each)	1	25	Squirrel-cage
Agitator screenroom soft stock chest	2	25	Squirrel-cage
Color pumps	1	5	Squirrel-cage
Mixer for groundwood, sulphite pulp, alum. and color	1	0.5	Squirrel-cage
Beater for sulphite laps	1	50	Wound-rotor
Wet machines	2	50	Wound-rotor
Jordans	4	150	Squirrel-cage
Screenroom fan	1	5	Squirrel-cage

MOTORS IN THE GROUNDWOOD MILL

Service	Number	Hp	Type
Conveyor (supply)	1	10	Squirrel-cage
Conveyors (over charging floor)	2	25	Squirrel-cage
Cutoff saw (charging floor)	1	5	Squirrel-cage
Ventilating fan	1	7.5	Squirrel-cage
Air compressors	1	2	Squirrel-cage
2—Heater fans (grinder room)	2	5	Squirrel-cage
Heater fan (grinder building)	1	15	Squirrel-cage
Heater fan (screen room)	1	15	Squirrel cage
Ventilating fan (grinder room)	1	5	Squirrel cage
2—Motor generator exciter sets	2	350	Squirrel cage
Grindstone trimmer	1	10	Wound rotor
Pumps (pressure for grinders)	4	50	Squirrel cage
Pump 6,300 g.p.m. (white water to grindstone)	1	100	Squirrel cage
Pump 252 g.p.m. (white water to grindstone)	1	100	Squirrel cage
4—Rotary knotter screws	1	10	Squirrel cage
2—14-in. pumps, 500 g.p.m. (stock to knotters)	2	100	Squirrel-cage
2—Second screens	1	50	Wound-rotor
Pumps, 2,400 g.p.m. (decker w.w. to tank)	1	75	Squirrel-cage
Pump 6-in. (save all stock to decker stock tank)	1	30	Squirrel-cage

MOTORS IN PAPER MACHINE ROOM

Service	Number	Hp.	Type
Pump, 2,900 g.p.m. (stock from mixing box)	1	60	Squirrel-cage
Pump, 2,000 g.p.m. (suction water to mixing box)	1	25	Squirrel-cage
Pump, 4,800 g.p.m. (stock to machine screens)	1	75	Squirrel-cage
4—Rotary machine screens	4	5	Squirrel-cage
Pump, 1,000 g.p.m. (fresh water to showers)	1	30	Squirrel-cage
Fourdrinier shaker	1	1	Squirrel-cage
2—Nash vacuum pumps (suction boxes)	2	100	Squirrel-cage
Fourdrinier section drive at couch roll	1	150	Direct-current
Fourdrinier section drive at couch roll	1	20	Synchronous
Nash vacuum pump (1st press suction roll)	1	100	Squirrel-cage
First press drive	1	100	Direct-current
First press drive	1	20	Synchronous
Second, third and fourth press drive	3	50	Direct-current
Second, third and fourth press drive	3	20	Synchronous
Driers	2	100	Direct-current
Driers	1	20	Synchronous
Calender drive	1	100	Direct-current
Calender drive	1	20	Synchronous
Fan for broke from calender to beater	1	15	Squirrel-cage
Reel drive	1	30	Direct-current
Reel drive	1	20	Synchronous
Reel hoist	1	3	Wound-rotor
Slitter drive	1	7.5	Wound-rotor
Fan to blow trimmings from slitter to beater	1	3	Squirrel-cage
Motor generator set for rewinder drive	1	50	Squirrel-cage
Motor generator set for rewinder drive	1	32	Direct-current

OTHER MOTOR DRIVES IN THE PAPER MILL

Service	Number	Hp.	Type
Broke beaters	2	50	Wound-rotor
Agitators in broke stock chest	2	5	Squirrel-cage
6-in. pump, 800 g.p.m. (broke stock to machine)	2	25	Squirrel-cage
Air compressors	2	100	Squirrel-cage
Machine-room heater fans	4	25	Squirrel-cage
Pump (hot-water return from heating system)	1	15	Squirrel-cage
Finishing-room rewinder	1	25	Wound-rotor

The Sixth National Exposition of Power and Mechanical Engineering

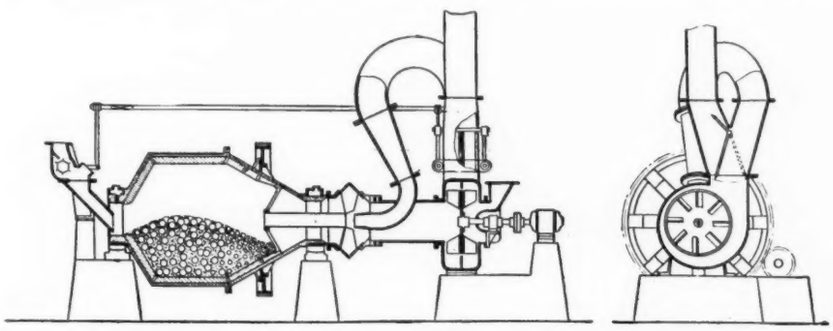
THE Sixth Annual Power Show, which will be held at the Grand Central Palace, New York City, December 5 to 10, will be an exposition of power and mechanical engineering in the broadest sense of the term.

At the first show, held in 1922, the entire exhibit was devoted exclusively to power-plant apparatus. The list of this year's exhibitors not only includes the important manufacturers of steam, electric, heating and ventilating equipment, but a considerable number of manufacturers whose products are more or less allied with this field. In the accompanying list only the former are included. This broadening of the field, as represented by the show, serves to make the exposition more national in scope and of more value to the engineer whose duties are confined to various industries and manufacturing problems, rather than with the generation and utilization of steam.

There appears to be a growing tendency on the part of the manufacturer to make his exhibit more attractive and of more general interest. This is seen in the extensive use of animated or scene-in-action pictures in place of large-sized models and in the showing of equipment of general interest, but not necessarily confined to the power plant. A good example of this will be found in the exhibit of the Standard Steel and Bearings, Incorporated, who expect to exhibit a Wright Whilrwind radial air-cooled motor, which will be a duplicate of the motor used in the three successful trans-Atlantic flights made during this year. The exhibit will also include a Pratt & Whitney "Wasp" radial air-cooled motor and a Curtiss D-12 V water-cooled motor.

In the field of pulverized-fuel equipment the developments made during the last year appear to have centered more around the burner than the pulverizer.

An improved Couch burner, in which have been incorporated a number of improvements including adjustable vanes, nozzles and distributor, will be shown by the Combustion Engineering Corporation, as well as a section of the improved C. E. air preheater plate-type which is now being made with clean-out doors, welded construction and a rearrangement of air and gas opening.



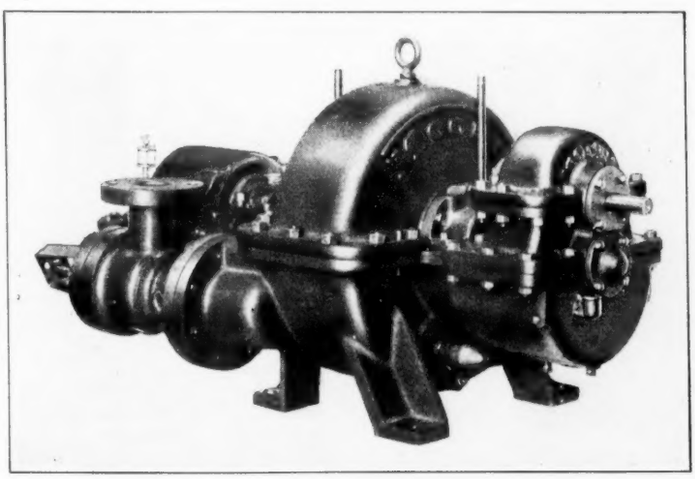
Hardinge unit coal pulverizer with reverse current classifier

Other new burners to be seen at the show for the first time will be the Drake superpower burner of the Furnace Engineering Company, the Riley flare-type burner, which was described in the Sept. 20 issue and the Peabody "Toronto" type burner of 8,000 lb. per hour capacity, which was described in the Oct. 4 issue. The Peabody Engineering Corporation will also feature an insulated front for its various types of burners.

Included in the exhibit of the Engineer Company will be a new combined gas and oil burner in which each fuel can be burned simultaneously or independently as desired.

In the field of unit coal pulverizers there will be a Hardinge improved conical ball mill equipped with reverse current classifier. This unit is now being built in sizes ranging from 150 lb. an hour to 30 tons an hour.

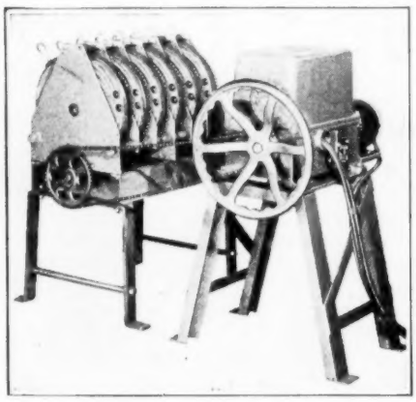
New boiler room instruments will be shown by a number of manufacturers. These will include the new Hays motor-driven recorder exhibited by the Paul B. Huyette Company, the new electrically operated "Mono" flue-gas analysis instrument for indicating and recording the percentage of CO as well as CO_2 by the C. J. Tagliabue Manufacturing Company. A "Stackmeter" for recording the CO_2 and stack temperature continuously on one chart by Charles Englehard, Inc., and a new gas



Moore combined turbine and reduction gear

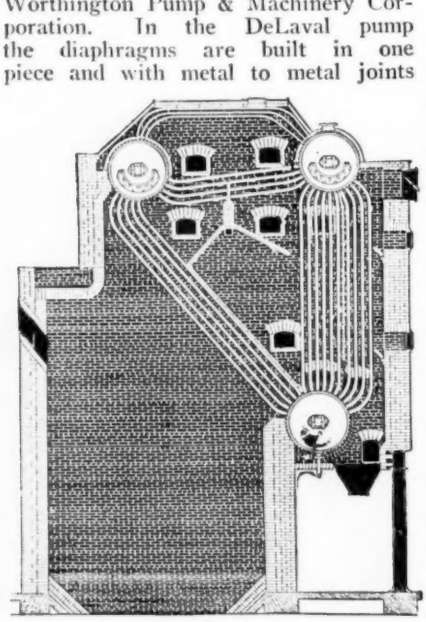
density regulator by the Smooth Engineering Corporation.

The latest development in boiler construction for pressures from 200 to 1,450 lb. will be shown by the Babcock & Wilcox Co. and the Walsh & Weidner Boiler Company. The latter company will also feature a solid water-cooled heat-absorbing wall for boiler furnaces. This wall was described in the Sept. 20 issue. A model of a new three-drum curved-tube boiler will be shown by the Wickes Boiler Company.



Bailey control drive for operating multiple regulating devices

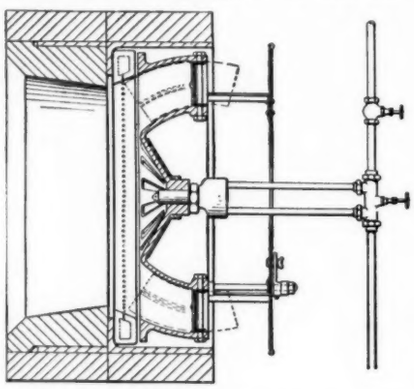
Recent developments in multi-stage centrifugal pumps for high-pressure boiler feeding will be shown by the De Laval Steam Turbine Company and the Worthington Pump & Machinery Corporation. In the DeLaval pump the diaphragms are built in one piece and with metal to metal joints with the casings at their peripheries. In the Worthington pump the upper case will be removed to show the construction of the volute diffuser, which it is claimed materially increases the efficiency of the pump.



Wickes three-drum curved-tube boiler

The important part that speed reduction gears are now playing in the industrial and power plant field is reflected in the number of new types that are found each year at the show. This year the Moore Steam Turbine Corporation will have a combined turbine and reduction gear, which has been designed primarily for moderate-speed auxiliary drive such as fans, and pumps running at speeds between 900 and 2,000 r.p.m. The unit is compact and takes up slightly more space than a turbine alone, the reduction gear being carried in an extension of the casing. The latest design of gear of the W. A. Jones Foundry & Machine Company and the Sykes and Caldwell units of the Link-Belt Co. will also be shown.

A worm gear reducer having what is probably the highest reduction ever attained in a single unit, 800,000 to 1, will be featured by the Albaugh-Dover Manufacturing Company. A new turbine stoker drive unit will be included in the exhibit of the Terry Steam Turbine Company.

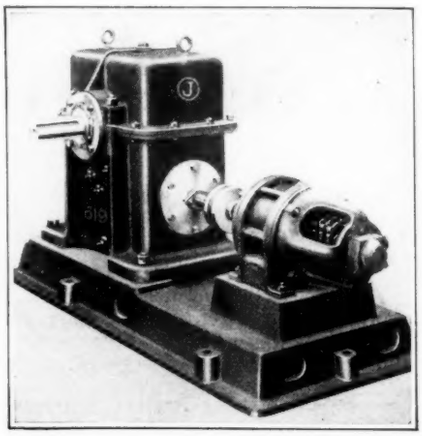


Combined gas and oil burner of the Engineer Co.

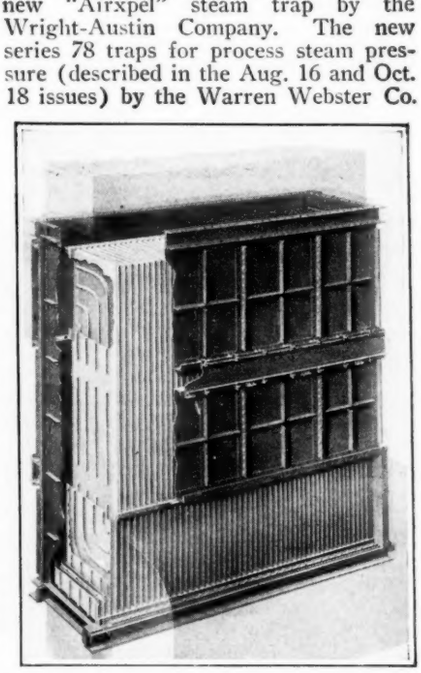
Additional miscellaneous equipment of recent development that will be found at the show is briefly as follows:

A "Sirocco" flue dust collector for removing fly ash from the exhaust gas from power plants, shown by the American Blower Company. A high temperature insulating brick by the Armstrong Cork & Insulation Company. A new design of control drive for operating fuel valves, rheostats, controllers, dampers and other regulating devices by the Bailey Meter Company. Carborundum blocks (Thayer type) for water-cooled furnace walls by the Bernitz Furnace Appliance Company. A centrifugal turbine-driven blower of the single-inlet single-stage type by the Elliott Company. A heat exchanger having a split shell giving access to the exterior of all the tube nest without removing the bundle by the O. E. Frank Heater & Engineering Co. Atomic-hydrogen welding outfit, which has made possible the production of ductile welds in iron and steel and the welding of special alloys by the General Electric Company. A cinder trap for removing cinders from flue gas (described in the Nov. 15 issue) by the Green Fuel Economizer Company. Electrically operated control apparatus for industrial uses by the Hagan Corporation. Pump regulator particularly adapted to boiler feed and fuel-oil pumps by the Leslie Company.

New type feed water regulators, controlled by a combination of steam flow and water level by the Northern Equipment Company and the Swartwout Company. The Helpbinger electric control for motor-operated reducing valves (described in the Sept. 13 issue) by the Schutte - Koerting Company. The "Kleervu" gage-glass protector (described in the Aug. 23 issue) and the new "Airxpel" steam trap by the Wright-Austin Company. The new series 78 traps for process steam pressure (described in the Aug. 16 and Oct. 18 issues) by the Warren Webster Co.



Heavy-duty reduction unit of the W. A. Jones Foundry and Machine Co.



The improved C-E air preheater

and the Yarway high- and low-pressure water columns, with "Sesure" inclined water gages (described in the Oct. 18 issue) by the Yarnall-Waring Company.

This brief review of the new products that will be exhibited has been made possible through advance information given us by the manufacturers. A more complete report will appear in the Dec. 13 issue.

Exhibitors at the Power Show and Their Products

A

ABSOLUTE CON-TAC-TOR CORP., Elkhart, Ind. *Booths 737-738*—Heating and refrigeration controls.

ACCURATE BRASS CASTING CO., INC., Brooklyn. *Booth 502*—An assortment of brass and copper forgings, brass and bronze castings.

ACETYLENE JOURNAL. *Booth 441.*

ADVANCE ENGINEERING CO., New York. *Booths 274-276*—Armstrong steam traps, Templeton pumping and lifting traps and Chicago-Wilcox gaskets.

AERO FIN CORP., Newark, N. J. *Booth 14A*—Heating units with extended surfaces.

AIR PREHEATER CORP., New York. *Booths 234-235*—"Scene-in-action" photograph of Ljunstrom air preheater showing its operation, also models, and photographs.

ALBAUGH-DOVER MFG. CO., Chicago. *Booth 674*—Worm and spur gear speed reducers. One reducer with a ratio of 800,000 to 1 will be shown.

ALEXANDER BROS., Philadelphia. *Booth 625*—Tentacular transmission belting.

ALLAN & SONS, Harrison, N. J. *Booths 485-486*—Segments for facing pistons of Diesel, Corliss and Uniflow engines and air compressors. Packing rings and valve disks.

ALLEN & BILLMYRE CO., INC., New York. *Booths 491-492*—Industrial vacuum cleaners and blowers.

ALLEN-SHERMAN HOFF CO., Philadelphia. *Booth 75*—Scence-in-action pictures displaying the method of operation of the A-S-H. hydro-jet ash removal system complete from furnace to ash loading hopper.

ALLIS-CHALMERS MFG. CO., Milwaukee. *Booths 516-517-518*—Texrope drive applications, roller-bearing motors models of hydraulic turbine runners, and a large model of a 30,000-kw. steam turbine unit for Consumers Power Co.

AMERICAN ABRASIVE METALS CO., New York. *Booths 730-731*—"Feralun," Bronzalun and Alumalun types of anti-slip stair treads and platforms.

AMERICAN AIR-COOLED BLOCK-ARCH COMBUSTION CO., New York. *Booth 567*—Flat-suspended air-cooled block-arch designed for delivering preheated air to boiler furnaces.

AMERICAN ARCH CO., INC., New York. *Booth 58*—Type A unit supported wall, Type C air-cooled wall and suspended furnace arch.

AMERICAN BLOWER CO., Detroit. *Booths 319-320-321-322*—Sirocco flue-dust collector, induced-draft fan, ventura disk ventilating fan and unit heaters.

AMERICAN BRASS CO., New York. *Booth 65*—Condenser tubes of admiralty and muntz metal, nickel bronze turbine blading, Tobin bronze piston rods and other copper and brass products. Also complete line of Anaconda sheets, rods, tubes, etc.

AMERICAN CAR FOUNDRY CO., New York. *Booth 201*—"Berwick" Electric rivet and bar heater, also forging heater.

AMERICAN ENGINEERING CO., Philadelphia. *Booth 208*—Lo-Hed electric hoists.

AMERICAN FOUNDRY EQUIPMENT CO., *Booth 448*—Sample casting for high pressures and temperatures.

AMERICAN MACHINE & FOUNDRY CO., Brooklyn. *Booths 423 to 428*—Rotary high-speed pumps.

AMERICAN PIPE BENDING MACHINE CO., Boston, Mass. *Booths 770-771*—Hand and motor-operated pipe-bending machines.

AMERICAN PULLEY CO., Philadelphia. *Booth 690.*

AMERICAN SCHAEFFER & BUDENBERG CORP., Brooklyn. *Booth 74*—Complete line of industrial instruments for indicator recording and controlling temperatures, pressures and speeds, also safety valves and steam traps.

AMERICAN SOCIETY HEATING & VENTILATING ENGINEERS. *Booth 573.*

AMERICAN SOCIETY OF MECHANICAL ENGINEERS. *Booth 80.*

AMERICAN STEAM PACKING CO., Needham Heights, Mass. *Booth 666*—Sheet and rod packings.

AMERICAN WATER SOFTENER CO., Philadelphia. *Booth 461*—Water treatment apparatus.

AMERICAN WELL WORKS, Aurora, Ill. *Booth 662*—Totally inclosed self-lubricating deep-well pump head, centrifugal pumps and vertical sump pumps.

ANACONDA COPPER MINING CO., New York. *Booth 65*—Admiralty and Muntz metal condenser tubes, nickel bronze turbine blading, bronze rods and tubes.

ANDALE ENGINEERING CO., Philadelphia. *Booth 324*—Duplex strainers and oil coolers.

ANDREWS-BRADSHAW CO., Pittsburgh. *Booth 17*—Tracyfier in operation under conditions that resemble those found in actual boiler operation as closely as possible.

ARCA REGULATORS, INC., New York. *Booth 233*—"Arca" automatic regulators.

ARMSTRONG CORK & INSULATION CO., Pittsburgh. *Booths 215-216*—High-temperature insulation for steam piping, also insulation for refrigerating plants.

ARMSTRONG MACHINE WORKS, Three Rivers, Mich. *Booth 275*—Complete line of Armstrong traps including steel trap for high pressures and a compound trap for handling large quantities of water at high and low pressures.

ASHTON VALVE CO., New York. *Booth 38*—Pop-safety valves, relief valves, pressure and vacuum gages, also master pilot gages with double illuminated dial.

ATLANTIC GEAR WORKS, Brooklyn. *Booth 626*—Various types of cast and cut gears.

ATLAS VALVE CO., Newark. *Booth 612*—Campbell feed-water regulator, reducing valves, damper and temperature regulators and pump governors.

ATWOOD & MORRILL CO., Salem, Mass. *Booths 552-553*—Atmospheric relief valves, reverse current valves, adjustable combustion regulator and damper controls.

AUTOMATIC WEIGHING MACHINE CO., Newark, N. J. *Booth 424*—Industrial automatic weighing machines.

B

BABBITT STEAM SPECIALTY CO., New Bedford, Mass. *Booth 90*—Chain operated valve wheels and specialties.

BABCOCK & WILCOX CO., New York. *Booth 55*—Various sections of forged-steel headers for pressures from 200 to 1,450 lb., sections of forged steel superheater boxes, Enduro and Toncan iron superheater and economizer tubes, also a mechanical oil burner fitted B. & W. No. 80 high-grade brick. Special shapes of this brick will also be shown.

BADGER, E. B. & SONS CO., Boston. *Booth 436*—Low- and high-pressure expansion joints.

BAILEY METER CO., Cleveland. *Booth 51*—Meter panel boards, with a complete line of boiler meters. Electrically and mechanically operated fluid meters, pressure and temperature recorders and multi-point gages. Also boiler meter control and a new design of boiler meter control drive for operating fuel valves, rheostats, controllers.

BALDWIN CHAIN & MFG. CO., Worcester, Mass. *Booth 750*—Roller type transmission chains.

BALLWOOD CO., New York. *Booth 346*—Special pipe joints and seamless steel piping.

BARCO MFG. CO., Chicago, Ill. *Booth 258*—Lubricated and balanced plug valves and flexible joints, also steam-jacketed valve for hot asphalt, tar, etc.

BARNES & JONES, Jamacia Plain, Mass. *Booths 312-313*—Modulation vapor and vacuum heating systems, thermostatic and vacuum traps, modulation steam and water valves.

BARTLETT HAYWARD CO., Baltimore. *Booth 529*—Sectionalized models of Fast's flexible couplings with photographs and drawings of special applications.

BAYER CO., St. Louis. *Booth 347*—Models K-2, O, and R. Bayer mechanical soot blowers, also high temperature and chromite air cooled, blower elements.

BEARINGS INDUSTRY CORP., New York. *Booth 482*—Industrial ball and roller bearings of the taper and cylindrical type.

BEARIUM BEARINGS, INC., Boston. *Booth 524*—Bearings for various services of non-seizing metals.

BEAUMONT, R. H. CO., Philadelphia. *Booth 50*—Central system of coal and ash handling, including skip hoist, tram car, suspension bunker weigh larry, ash gates and cable drag scraper.

BELFIELD, H. CO., Philadelphia. *Booth 673*—Brass and iron expansion joints, reducing and regulating valves, globe valves and gland packed all-iron cocks, specially developed for the rayon industry.

BERNITZ FURNACE APPLIANCE CO., Boston. *Booth 78*—A complete section of a typical water wall fitted with carborundum water-wall blocks. Also ventilated types and carborundum S-100 boiler furnace blocks.

BETHLEHEM STEEL CO., Bethlehem, Pa. *Booths 70-71*—Bethlehem coal pulverizer of the roll tire type with dust-proof bearings, also demonstration models of Bethlehem backlash eliminator and torque amplifier.

BETHLEHEM SHIPBUILDING CORP., Bethlhem, Pa. *Booth 70*—Diesel engines, oil burning and pumping equipment, Bethlehem-Weir and centrifugal boiler feed pumps.

BIGELOW CO., THE, New Haven, Conn. *Booth 68*—Drawing showing recent designs

and developments of the Bigelow-Hornsby boiler and the Bigelow fire-tube boilers, also Bigelow electric steam generators.

Bigelow L. C. & Co., Inc., New York. *Booth 251*—Ganschow worm-gear speed reducers.

Blaw-Knox Co., Pittsburgh. *Booth 618*—Steel grating, clamshell buckets and continuous regenerative air heaters.

Boig & Hill, New York. *Booth 10*—"Curtis" engineering specialties including reducing valves, damper and temperature regulators, steam traps, water and pump pressure regulators.

Boiler Engineering Co., Newark, N. J. *Booth 450*—"Beco" boiler baffle wall with corrugated sheet metal separators.

Bond Foundry & Machine Co., Lancaster Pa. *Booth 611*—Casters for industrial and power plant trucks of all types, shaft couplings and hangers.

Borden Co., The, Warren, Ohio. *Booth 459*—Pipe threading tools, cutters and portable power drives for hand machines.

Boston Gear Works Sales Co., Norfolk Downs, Mass. *Booths 213-214-340-341-342*—Boston standardized speed reducers. Renold-Boston silent and roller-chain drives.

Botfield Refractories Co., Philadelphia. *Booth 325*—Adamant gun for applying furnace linings. Adamant fire-brick cement and Adachrome refractory material.

Bowser, S. F. & Co., Fort Wayne, Ind. *Booth 739*—Equipment for storing, dispensing and filtering lubricating oils, also Xacto meter for fuel oil lines to burners.

Bristol Co., The, Waterbury, Conn. *Booth 12*—Complete line of indicating and recording gages and thermometers, pyrometers and liquid level gages.

Brown Instrument Co., Philadelphia. *Booth 34*—Large model of the Brown electric flow meter, indicating and recording thermo-electric pyrometer, electric CO_2 meters, tachometers, indicating and recording thermometers.

Buffalo Forge Co., Buffalo. *Booth 73*—Fans, blowers, exhausters and coolers.

Buffalo Steam Pump Co., Buffalo. *Booth 73*—Centrifugal boiler feed pumps and a non-clogging sewage pump.

Builders Iron Foundry Co., Providence, R. I. *Booths 276-277*—Venturi meter for steam and boiler feed, also new shunt steam meter for small pipe lines.

Builder Iron & Steel Co., Everett, Mass. *Booth 468* — Thatcher overfeed stokers for boilers from 1,000 to 5,000 sq.ft. of heating surface.

Bundy Steam Trap Co., Nashua, N. H. *Booth 8*—Complete line of Bundy steam traps.

Burhorn, Edwin Co., New York. *Booth A*—Model of Burhorn "Smaltower" in operation.

Byers, A. M. Co., New York. *Booth 443*—Byers genuine wrought-iron pipe.

C

Cameron, A. S. Steam Pump Works, New York. *Booth 554*—Cameron direct-acting and centrifugal pumps.

Carborundum Co., Perth Amboy, N. J. *Booth 22*—Four sections of boiler settings showing the application of carborundum bricks and shapes to air-cooled walls and water-tube side walls. Also "Infrax" insulating brick.

Carr Fastener Co., Cambridge, Mass. *Booth 744*—Complete line of "Dot" lubricating devices.

Carrick Engineering Co., Chicago. *Booth 295*—Electrically and hydraulically operated control for automatic regulation of combustion in boiler furnaces.

Carrier Engineering Co., Newark, N. J. *Booth 14A*—A complete new model of Carrier centrifugal refrigeration unit, unit air conditioner for industrial plants, a gas heating and air conditioning unit for the home and a Gordon drier.

Casey-Hedges Co., Chattanooga, Tenn. *Booth 343*—Model of multi-pass boiler, also parts of boilers to show method of construction.

Cash, A. W. Co., Decatur, Ill. *Booth 28*—Reducing valves, pump governors and Craig system of automatic combustion control.

Celite Products Co., Los Angeles. *Booth 14*—Sil-O-Cel insulating material, Celcote, and Fraxite high-temperature cement.

Centrifix Corp., Cleveland. *Booths 302-303*—Line of purifiers for steam, air and gas.

Century Electric Co., St. Louis. *Booths 712-713*—Automatic starting induction motors, single-phase repulsion start motor and portable fans.

Chapman Valve Mfg. Co., Indian Orchard, Mass. *Booth 2*—Chrome nickel steel gate valves, motor units for operating large valves. Also line of standard bronze and iron gate valves.

Chicago Chemical Co., Chicago. *Booth 693*—Testing kits demonstrating the use of sodium aluminate in connection with the treatment of boiler water.

Chicago Pump Co., Chicago. *Booths 636-637-638-639* — Centrifugal pumps, including bilge pumps, vacuum and condensation pumps and receivers.

Chicago-Wilcox Co., Chicago. *Booth 274*—Metallic-asbestos pipe gaskets.

Clarage Fan Co., Kalamazoo, Mich. *Booths 245-246*—Unit humidifier and unit heater.

Clements Mfg. Co., Chicago. *Booth 773*—Portable electric vacuum cleaners and blowers.

Clipper Belt Lacer Co., Grand Rapids, Mich. *Booth 551*—Complete line of Clipper belt laces.

Cochrane Corp., Philadelphia. *Booth 67*—Conical strainerless filter with single control and constant flow valves, pipe flow meter, deaerating heater and vent condenser, separators, high-pressure drainers and back-pressure valves.

Coen Co., Inc., San Francisco. *Booths 15-B*—Oil pumping, heating and burning equipment.

Coffin Valve Co., Boston. *Booths 408-409*—Kelty motor drive unit, Dow disk-arm pivot valve with hydraulic cylinder and solenoid operated control valve.

Combustion Engineering Corp., New York. *Booth 24*—Pulverized-coal equipment, air preheaters, stokers and water-cooled furnace walls.

Combustion Publishing Co., New York. *Booth 53.*

Combustion Sales Co., Inc., New York. *Booth 728*—Observation windows for boiler furnaces.

Connery & Co., Inc., Philadelphia. *Booth 43*—Sections of breeching showing improved expansion stiffener and welded construction, also improved air cooled damper.

Continental Valve & Equipment Co., Farmington, Mass. *Booth 316*—Forged-steel high-pressure pipe fittings, forged-steel unions, governors and reducing valves.

Cook Electric Co., Chicago. *Booth 710*—Metal bellows of monel brass and bronze, fuel oil pumps and regulating devices, damper regulators, valves, traps and other specialties.

Cooper Hewitt Electric Co., Hoboken, N. J. *Booth 504*—Operating exhibit of mercury-vapor lighting ar[illegible]C-H. Konnec-tors.

Cork Foundation Co., Inc., New York. *Booths 760-761*—"Absorbo" cork foundation mats.

Cory, Chas. & Son, Inc., New York. *Booths 241-242*—Complete line of Cory signaling, communicating, lighting and control equipment, including thermostatic control systems, electric valve operators, load indicators and turbine order signal systems.

Crandall Packing Co., Palmyra, N. Y. *Booth 755*—Complete line of metal packings and exhibits of raw materials entering into the manufactured packings.

Crane Co. *Booths 52* and *462-463-464*—Line of cast-steel valves for pressures up to 900 lb., trimmed with stainless steel; also iron and brass body valves in standard types and a steel pipe type of steam separator.

Crankless Engines, Ltd., New York. *Booths 758-759.*

Crosby Steam Gage & Valve Co., Boston. *Booth 98*—Nozzle-type safety valve for 1,500 lb. pressure, reseating tool which permits the reseating of safety valves in position on the boiler, steam gages and full-way blow-off valves.

Crouse-Hinds Co., Syracuse, N. Y. *Booth 610*—Wiring conduits and fittings.

Cutler-Hammer Mfg. Co., Milwaukee. *Booths 454-455*—Across-the-line automatic starters, tubular and space heater and Dean system of valve control.

Cutter Electrical Mfg. Co., Philadelphia. *Booth 14B*—Air carbon circuit breakers for use on circuits up to 700 volts. A feature will be 40,000-amp. 525-volt d.c. solenoid-operated breaker, also U-Re-Lit breakers.

D

Dampney Co. of America, Boston. *Booth 248*—Apexior protective coatings for metal surfaces and the equipment for applying the coating.

Davidson, M. T. Co., New York. *Booths 36-37* — Several types of direct-acting steam pumps of the simplex type.

Davis Engineering Corp., New York. *Booths 415-416*—Feed-water heaters, oil coolers, filters and grease extractors, instantaneous heaters and traps.

Davis, G. M. Regulator Co., Chicago. *Booth 267*—Pressure regulators of the piston and diaphragm type, stop and check valves, back-pressure and relief valves.

Dean Payne, New York. *Booth 16*—Power operated swing gate valves.

Dearborn Chemical Co., Chicago. *Booth 13*—Exhibit explaining the Dearborn method of treating boiler feed water, also "No-Ox-Id" rust preventive.

De Bothezat Impeller Co., New York. *Booth 769*—Various sizes of propeller type fans, double-disk mining fan, and air filtering unit.

De Laval Separator Co., New York. *Booths 536-539*—Two vertical and one horizontal type oil purifier and a crankcase oil reclaiming outfit.

De Laval Steam Turbine Co., Trenton, N. J. *Booths 540-543*—High-pressure centrifugal boiler-feed pump, small steam turbine, centrifugal compressor, various types of worm reduction gears and flexible couplings.

D'Este Julian Co., Boston. *Booth 10*—"Curtis" steam specialties including pressure-reducing valves, steam traps, combustion controls and tank valves.

Detrick M. H. Co., Chicago. *Booth 94*—Full-sized model of sectionally supported

refractory [illegible], also small model of furnace wall and arch.

DETROIT STOKER CO., Detroit. *Booths 203-204-205*—Single, double and multiple retort underfeed stokers with demonstration of the method of individual control of the distribution of fuel in each retort.

DE WATERS SAFETY LATCH CO., INC., New York. *Booth 263*—Models of De-Waters safety latch.

DIAMOND POWER SPECIALTY CORP., Detroit, Mich. *Booth 16*—Samples of Diamond hand and electrically operated soot blowers.

DICKSON WALTER S. & CO., New York. *Booths 232-233*—Heating and ventilating apparatus.

DIXON, JOS. CRUCIBLE CO., Jersey City, N. J. *Booth 254*—A complete line of graphite and graphite lubricants and a lubricant testing machine.

DODGE, F. W. CORP., New York. *Booth 27*—Sweet's Engineering Catalog.

DODGE MFG. CO., Mishawaka, Ind. *Booths 465-466-469-470*—Power transmission equipment including shaft hangers, split pulley and bearings.

DRAKE NON-CLINKERING FURNACE BLK. CO., New York. *Booths 227-228*—Power burner for pulverized fuel. Improved SX air-cooled wall; Simplesse gas heat burner and standard furnace blocks.

DRI-STEAM VALVE SALES CORP., New York. *Booth 607*—Stop valves in the angle and globe types of cast-iron semi-steel, bronze and steel.

DUNHAM, A. C. CO., Chicago. *Booths 701-702*—A working unit of the Dunham differential vacuum pump, condensation pump and receiver, also thermostatic radiator traps and valves.

DURABLA MFG. CO., New York. *Booth 236*—Metal pump valve units, sheet and rod packings.

DURAMETALLIC CORP., Kalamazoo, Mich. *Booth 749*—Durametallic packings in spiral form, also wedge and tapered junc ring assemblies.

E

EASTERN STEAM SPECIALTY CO., New York City. *Booth 440*—Steam specialties.

ECONOMY PUMPING MACHINERY CO., Chicago. *Booth 471*—Centrifugal boiler feed and standard pumps, automatic sump and return line pumps, non-clogging sewage pump.

EDGE MOOR IRON CO., Edge Moor, Del. *Booths 288-289-290*—Full-sized hammer-welded boiler drum designed for high pressure service and for single-pass boiler for the Oklahoma Gas & Elec. Co., also photographs of the types of boilers made by this company.

EDWARD VALVE & MFG. CO., East Chicago, Ind. *Booth 30*—Full line of forged steel valves for high pressure and temperatures, including the offset body and pillar type yoke construction.

ELLIOTT CO., Jeanette, Pa. *Booths 271-272-273*—New type of turbine-driven centrifugal blower of the single-inlet, single-stage, overhung type to operate at 3,600 r.p.m., also turbines, condensers, ejectors and other equipment.

ELLISON, LEWIS M., Chicago, Ill. *Booth 44B*—Single- and multi-tube inclined and vertical draft gages, U-path steam calorimeter, also new line of dial draft gages.

ENGELHARD, CHARLES, INC., New York City. *Booth 675*—Indicating and recording pyrometers, automatic temperature control apparatus and the new Engelhard stack meter.

ENGINEER CO., New York City. *Booth 18*—Enco hydraulic system of combustion control, electric pressure regulator and damper regulator, new combined oil and gas burner and Enco baffles.

ENGINEERING PRODUCTS CORP., New York City. *Booths 742-743*—"Epco" masks and "Epco" ray screens.

ENGINEERS BOOK SHOP, New York City. *Booth 28A*—Technical books.

ERIE CITY IRON WORKS, Erie, Pa. *Booths 221-222*—Unitype coal pulverizer. Model of three-drum inclined water-tube boiler, with integral economizer, also Seymour basket-type water-cooled refractory-lined furnace for pulverized-fuel firing.

ERNST & CO., Newark, N. J. *Booth 76*—Water columns with inclined gage glass, also gage-glass valves.

EVERLASTING VALVE CO., Jersey City, N. J. *Booths 100-101*—Regular and improved line of Everlasting valves in the angle and tandem types for pressure up to 600 lb.

EX-CELL-O TOOL & MFG. CO., Detroit, Mich. *Booth 664*—Precision parts for Diesel engines, such as fuel-injection pump and spray nozzle. Also precision parts for air-craft engines

F

FAFNIR BEARING CO., New Britain, Conn. *Booth 246*—Complete line of standard ball bearings in single- and double-row types, and radial thrust bearings, also hanger boxes, pillow blocks, loose pulley, etc.

FAIRBANKS-MORSE & CO., Chicago. *Booths 326-331*—Ball-bearing centrifugal pumps and motors, reciprocating pumps and a Diesel engine generating set.

FALK CORP., Milwaukee, Wis. *Booths 338-339*—Type "D" herringbone gear speed reducers and flexible couplings.

FEDERAL GAGE CO., Chicago. *Booths 535-544*—Indicating and recording gages for pressure and vacuum, also "mercoid" switches for various uses in controlling pressures and temperatures.

FISHER GOVERNOR CO., Marshalltown, Iowa. *Booth 35*—Pump governors, reducing valves, steam traps, float valves, and liquid-level controllers both direct connected and remote controlled.

FLEXIBLE STEEL LACING CO., Chicago. *Booth 547*—Alligator steel belt lacing, belt fasteners and expanded steel guards for electric lamps.

FLORANDIN EQUIPMENT CO., New York. *Booth 298*—Cranes and hoists.

FLYNN & EMRICH CO., Baltimore. *Booth 46*—Huber mechanical stokers.

FOOTE BROS. GEAR & MACHINE CO., Chicago, Ill. *Booth 550*—Spur- worm- and herringbone-gear speed reduction units, and flexible couplings.

FOSTER ENGINEERING CO., Newark, N. J. *Booth 84*—Several different types of pressure regulators and pump governors, back-pressure and relief valves, also drop-forged cast-steel chrome construction, non-return stop valves, fan-engine regulators and flow box in practical demonstration.

FOSTER-WHEELER CORP., New York. *Booth 64*—Foster sectional oil heater, sections of Foster economizer and water-cooled furnace walls, steam-jet vacuum pumps and Aero unit coal pulverizer.

THE FOUNDATION CO., New York City. *Booths 296-297.*

FOXBORO CO., INC., Foxboro, Mass. *Booth 62*—Boiler water level recorder, indicating and recording thermometers and gages, flue gas recorders and tachometers.

FRANK, O. E. HEATER & ENGR. CO., Buffalo. *Booth 657*—Heat exchangers with split shell giving access to the tube bundle, also a U-tube storage type heater.

THE FREDERICK IRON & STEEL CO., Frederick, Md. *Booths 405-406*—A double-suction single-stage centrifugal pump and a four-stage boiler feed pump with hydraulic balancing feature.

FULLER-LEHIGH CO., Fullerton, Pa. *Booth 54*—Bailey water-cooled furnace wall and pulverized coal equipment, also drawing and photographs of installations made by the company.

FULTON CO., Knoxville, Tenn. *Booths 252-253*—"Sylphon" pressure and temperature regulators and interlocking valve for fuel-oil systems.

FURNACE ENGINEERING CO., New York City. *Booth 41*—Simplex unit pulverizer equipped with independent motor-driven feeder and magnetic separator together with fuel piping and burners. Also "Drake" armour-clad wall construction.

G

G & G ATLAS SYSTEMS, INC., New York. *Booths 86-87-88*—"Atlas" pneumatic tube systems.

GANSCHOW, WM. & CO., Chicago. *Booth 251*—Several types of speed transformers and worm-gear speed reducers.

GARDEN CITY FAN CO., Chicago. *Booth 685*—Multiblade and propeller-type fans and blowers, also unit heaters.

GARLOCK PACKING CO., Palmyra, N. Y. *Booths 545-546*—Types of mechanical packing made of asbestos and rubber, "Garlock" oil-return wall-plate metal packing, metal ammonia packing and cord plugs for cleaning condenser.

GENERAL ELECTRIC CO., Schenectady, N. Y. *Booths 4-5*—Steam turbines, motors, motor controls, flow-meter equipment, battery charging and atomic-hydrogen welding equipment.

GENERAL REFRACTORIES CO., New York City. *Booths 344-345*—Various classes of refractories including sized firebrick "Brasbrix" and Grefco chrome high-temperature cement.

GIBBY ENGINEERING CO., East Boston, Mass. *Booth 233*—Hand stokers.

GILLIS & GEOGHEGAN, INC., New York City. *Booths 86-87-88*—Hand and electric operated telescopic hoists for ash removal.

GRITANNER ENGINEERING CORP., New York City. *Booth 206*—Steam-jet and hydraulic ash conveyors, soot and flyash removal systems, also model sized storage tank and a line of ash pit and furnace doors.

GOETZE GASKET & PACKING CO., New York. *Booth 252*—Corrugated metal and asbestos filled pipe flange and cylinder gaskets.

GOLWYNEE, HENRY A. & CO., New York. *Booths 429-430*—The refractory "Shamva" Mullite in forms of brick and various shapes, crucibles and electric porcelain insulators.

GORDON, JAMES T., CO., New York City. *Booth 92*—"Nicholson" steam specialties, and Cleveland worm reduction units.

A. P. GREEN FIREBRICK CO., Mexico, Mo. *Booth 202*—Special high alumina brick, high-temperature air setting cement, and special "quik pach" plastic firebrick. Also standard line of firebrick, special fireclay, firebrick mortars and high-temperature cements.

GREEN FUEL ECONOMIZER CO., Beacon, N. Y. *Booths 648-649-658-659*—Tubular- and plate-type air preheaters, forced-draft fan and a working model of a cindertrap recently developed.

GRINNELL CO., Providence, R. I. *Booths 530-531-548-549*—Types of pipe joints including reinforced laps with plain, tongue and groove and Sargol faces, also brackets, hangers, and cast-iron fittings.

THE GRISCOM-RUSSELL CO., New York City. *Booth 49*—U-fin air coolers, bent-tube evaporators, multiwhirl cooler and Reilly water heater.

H

HAGAN CORP., Pittsburgh, Pa. *Booth 21*—Combustion-control apparatus, deconcentrators, steam purifiers, and an electrically operated control apparatus for industrial furnaces.

HANS-RENOLD CO., New York. *Booth 342*—Silent transmission chain.

HARDINGE CO., York, Pa. *Booth 28 & M*—Working models of the Hardinge conical mill and the reverse-current classifier and a model of Ruggles-Coles dryer. Also a model of the new unit coal pulverizer made in sizes from 150 lb. to 30 ton per hour.

HAYS CORPORATION, Michigan City, Ind. *Booth 81*—Gas analysis instruments and draft gages.

HEATING & VENTILATING MAGAZINE CO., New York. *Booth 651.*

HEINE BOILER CO., St. Louis. *Booth 24.*

HEMPHILL A. J. CO., INC., New York *Booth 611*—Truck casters, belting, gears, roller bearings and power transmission machinery.

HENDRICK MFG. CO., Carbondale, Pa. *Booth 431*—Perforated metal screens, elevator buckets, interlocked steel grating and spur-site stair treads.

HENSZEY DECONCENTRATOR CO., Chicago. *Booth 31*—Henszey deconcentrator with continuous blowdown.

HILL, E. VERNON CO., Chicago. *Booth 212*—Air testing instruments, filter gages, pitot tubes, dust testing outfits, psychrometers and microscopes.

HISEY-WOLF MACHINE CO., Cincinnati. *Booth 754*—Electric drills, grinders and buffers.

HOFFMAN SPECIALTY CO., INC., Waterbury, Conn. *Booths 633-634*—Hoffman specialties, including air valves and heat-control apparatus.

M. A. HOFFT CO., Indianapolis, Ind. *Booth 323*—National hand stoker and furnace arch.

HOMESTEAD VALVE MFG. CO., Homestead, Pa. *Booth 444*—Standard line of Homestead products, including quarter-turn valves, three- and four-way lubricated plug valves, combination blowoff valves and protected-seat hydraulic operating valves remote control type, also a device for cleaning oil and grease off machinery, stripping paint, etc.

HUBER STOKER CO., New York. *Booth 46*—Huber hand stokers.

HUHN MFG. CO., New York. *Booth 756*—Huhn metallic packing.

HUTCHINSON MFG. CO., INC., New York City. *Booth 704*—Woodworking machinery and tools.

PAUL B. HUYETTE CO., Philadelphia, Pa. *Booths 81-82*—Complete line of Hay's instruments including a new motor-driven CO_2 recorder, a boiler panel including a flowmeter, draft recorder, pyrometer high- and low-water alarm and pressure gage.

HYATT ROLLER BEARING CO., Newark, N. J. *Booths 497-498*—Roller bearings for all kinds of transmission equipment.

I

ILG ELECTRIC VENTILATING CO., Chicago, Ill. *Booth 278*—Multiblade blowers, unit heaters and propeller type fans.

ILLINOIS ENGINEERING CO., Chicago. *Booth 232*—Eclipse steam traps and other steam and vapor specialties.

INDUSTRIAL POWER, Chicago. *Booth 740.*

INGERSOLL-RAND CO., New York. *Booths 554-5-6-7*—Complete line of Cameron pumps including a class "HMT" high-pressure multi-stage centrifugal boiler feed pump equipped with a hydraulic balancing drum to neutralize end thrust.

INSTANT WATER HEATER SALES DIVISION, Chicago. *Booth 440.*

INSULATING PRODUCTS CORP., New York City. *Booth 437*—Heat insulating products for various services.

INTERNATIONAL COMBUSTION ENGINEERING CORP., New York City. *Booths 23, 24, 25*—Scene-in-action displays of various types of equipment, also "Couch" adustable vane burner for pulverized coal and improved air preheater.

THE INTERNATIONAL NICKEL CO., New York. *Booth 9*—Commercial forms of monel metal and nickel alloys. Also a collection of important parts of power plant equipment as produced by the various manufacturers.

INTERNATIONAL STEAM ENGINEER, Chicago, Ill. *Booth 506.*

IRVING IRON WORKS CO., Long Island City, N. Y. *Booths 438-439*—Irving subway flooring and vizabledg safestep.

IRON FIREMAN AUTOMATIC STOKER CORP., New York. *Booths 682-683*—Iron fireman automatic underfeed coal burner.

J

D. O. JAMES MFG. CO., Chicago, Ill. *Booth 752*—Worm, spur and herringbone speed-reduction units.

JENKINS BROS., New York City. *Booth 90*—Full line of bronze and iron valves in both globe and gate types, "selclo" and rapid action types, also rubber packing and moncrieff gage glasses.

JOHNS-MANVILLE, INC., New York City. *Booths 314-315*—Raw asbestos and the processes by which it is converted into the various products including packings, insulating materials, roofing, etc.

JOHNSON SERVICE CO., Milwaukee. *Booths 403-404*—Heat-regulating devices.

JONES, W. A. FOUNDRY & MACHINE CO., Chicago, Ill. *Booth 493*—Spur- and worm-gear speed reducers, miscellaneous power-transmission appliances.

JUSTUS STEAM TRAP CO., Napanock, N. Y. *Booth 715*—"Justus" steam traps and thermostats.

K

KEATING, E. L. PIPE BENDING & SUPPLY CO., Hartford, Conn. *Booths 229-230*—Samples of fabricated piping for high and low pressures, including reinforced square-corner Vanstone joints, welded flanges and nozzles, pipe bends and coils for refrigeration and chemical processes.

KEELER, E. CO., Williamsport, Pa. *Booth 211*—Working models of the Keeler return-tubular, cross- and long-drum water-tube boilers and also the double-duty boiler.

KELLOGG, M. W. CO., Jersey City, N. J. *Booth 16*—Samples of forge welded tongue and groove flanged joints, Kellogg-Van Stone pipe joints, forge welded pipe nozzle. "Dean" swing gate and slide gate valves power operated.

KENNEDY-VAN SAUN MFG. & ENG. CO., New York. *Booth 291*—Animated picture of "Kennedy" pulverized coal equipment operating a steam boiler.

KERR TURBINE CO., Wellsville, N. Y. *Booth 271*—A Kerr turbine generating unit.

KEYSTONE LUBRICATING CO., Philadelphia, Pa. *Booth 3*—Keystone safety lubricator in the hand, spring automatic and pneumatic operated types, also general line of Keystone lubricants.

KEYSTONE REFRACTORIES CO., New York City. *Booth 11*—Dura-stix bonding mortar, steel-veneer granular refractory, and a refractory sprayer for coating furnace linings and general repairing.

KIELEY & MUELLER CO., New York City. *Booths 533-534*—Steam specialties including back-pressure, atmospheric-relief, reducing, stop and check valves.

KING REFRACTORIES CO., Buffalo, N. Y. *Booth 95*—"Mono" boiler baffles and furnace cements.

KINGSFORD FOUNDRY & MACHINE CO., Oswego, N. Y. *Booth 490*—Section water-tube boilers and centrifugal pumps.

KISSICK-FENNO CO., INC., New York City. *Booth 19*—"Copes" feed-water regulators, and pump governors, also Vulcan soot cleaners.

KLEMP, WM. F. CO., Chicago. *Booth 757*—Floor and stairway grating.s

KLINGERIT, INC., New York City. *Booth 317*—High-pressure asbestos sheet packing, semi-metallic stuffing-box packing, piston valves, reflex steel high-pressure water gages and asbestos high-pressure valve disks.

KORFUND CO., New York City. *Booth 627*—Korfund vibro-dampers for isolating machinery against transmission of vibration and noise.

L

LADD WATER TUBE BOILER CO., Pittsburg. *Booth 25.*

LAMONT CORP., New York City. *Booth 619*—LaMont waste-heat steam generator, steam-flow duplex valve and water-film screen for H.R.T. boilers.

LANDIS MACHINE CO., Waynesboro, Pa. *Booth 708*—Pipe threading and cutting machinery, also collapsible and adjustable taps.

LEAD LINED IRON PIPE CO., Wakefield, Mass. *Booth 86*—Lead and tin-lined iron pipe, valves, fittings and stop cocks.

LEAVITT MACHINE CO., Orange, Mass. *Booth 568*—Dexter, globe, gate, and pump valve-reseating outfits.

LEEDS & NORTHRUP CO., Philadelphia, Pa. *Booths 432-433-434*—Electric CO_2 recorders, electric flow-meter designed to obviate inaccuracy from lead and contact resistances or line voltage variations; generator-field temperature recorder, frequency recorder and L. & N. metered combustion control system.

LESLIE CO., Lyndhurst, N. J. *Booth 505*—Several classes and types of automatic pressure regulators and reducing valves, relief valves and strainers.

LINCOLN ELECTRIC CO., Cleveland. *Booths 766-767*—Linc-weld motor and Stable-arc welder, also two speed elevator motor.

LINDE AIR PRODUCTS CO., New York City. *Booths 265-266*—Welding apparatus and supplies.

LINK-BELT CO., Chicago. *Booths 677-678-679*—"Sykes" herringbone speed reducers, anti-friction belt conveyor idler "Caldwell" speed reducers and silent chains.

LIPTAK FIRE-BRICK ARCH CO., Mexico, Mo. *Booth 202*—Type S furnace wall construction for pulverized coal furnaces, single and double-suspension arches, special arch block of high alumina or diaspore material, also type X refractory furnace wall construction.

LIQUIDOMETER CO., INC., Long Island City, N. Y. *Booth 672*—Liquid level tank gages in indicating and recording types.

LOCKE REGULATOR CO., Salem, Mass. *Booth 445*—Damper regulators, balanced valves, pump governors, reducing valves and engine stops.

LONG, E. G. CO., New York City. *Booth 752*—Products of the D. O. James Mfg. Co., and the American High-Speed Chain Co.

LUNKENHEIMER Co., Cincinnati, Ohio. *Booth 63*—A complete line of bronze, iron body, steel and monel-metal valves.

M

McCLAVE-BROOKS Co., Scranton, Pa. *Booths 561-562-563*—Shaking and dumping grates and forced-draft chain-grate stokers for small-sized anthracite and bituminous coal.

McLEOD & HENRY Co., Troy, N. Y. *Booth 13*—"Steel mixture" firebricks, veneer wall blocks, high-temperature cements, and flat suspended arches.

McNUTT, W. H. INC., New York. *Booth 742*—Power-plant safety devices.

MANISTEE IRON WORKS Co., Manistee, Mich. *Booths 219-220*—Rees roturbo centrifugal pumps including one of the multistage horizontally split type and a single-stage horizontal volute pump.

MANNING, MAXWELL & MOORE, INC., New York City. *Booth 60*—Ashcroft gages and specialties. Consolidated safety valves, Metropolitan injectors and Hancock valves of bronze, cast steel and forged steel.

MANZEL BROTHERS Co., Buffalo. *Booth 705*—Complete line of force-feed lubricators, also a special lubricator for timed lubrication of Diesel engines.

MARLIN-ROCKWELL CORP., Jamestown, N. Y. *Booth 337*—Complete line of Gurney ball bearings.

MASON REGULATOR Co., Boston. *Booths 223-224*—Mason line of pressure regulators, reducing valves, pump-pressure regulators and speed governors, hydraulic damper regulators, float valves and strainers.

MAXIM SILENCER Co., Hartford, Conn. *Booth 654*—Maxim silencer in operation on a small blower, also silencers for Diesel, gas, and steam engines.

MERCON REGULATOR Co., THE, Chicago, Ill. *Booth 31*—Various types of Mercon pressure regulators, including a constant excess pressure regulator for boiler-water level controllers.

MERRICK SCALE MFG. Co., Passaic, N. J. *Booths 237-240*—Merrick mechanical weightometer in operation. A mechanical Weighman operation on weigh tanks, also the Merrick addoweight for weighing buckets on an overhead track system while in motion.

MERRITT, L. R. & Co., New York City. *Booth 32*—Steam specialties.

MIDWEST PIPING & SUPPLY Co., St. Louis, Mo. *Booth 268*—Midwest joints for superheated steam at pressures of 900 lb. A modification of the joint for high-pressure drip and drain lines. Also sample of pipe bends with short radius.

MIXING EQUIPMENT Co., INC., New York City. *Booth 3-E*—Various models of electric portable mixers for mixing practically all kinds of fluids.

MODINE MANUFACTURING Co., Racine, Wis. *Booth 635*—Unit heaters and humidifiers.

MOORE STEAM TURBINE CORP., Wellsville, N. Y. *Booths 508-509*—A combined turbine and reduction gear, turbine-driven boiler-feed pump, a pinion of a 1,500-hp. reduction gear and a turbine wheel from a 1,000-kw. unit.

MORSE CHAIN Co., Ithaca, N. Y. *Booths 262-263*—Silent chains of different sizes in operation. Rocker-joint construction of the chain will be featured.

MOTO-METER Co., INC., Long Island City, N. Y. *Booths 256-257*—Motoco industrial thermometers and pressure gages.

MURRAY CONDUIT SYSTEM, New York City. *Booth 300*—Apparatus for the construction of monolithic concrete conduits.

MURRAY, THOMAS E., INC., New York City. *Booth 301*—Photographs and cross-section drawings of power plants designed and installed by this company.

MUTTON HOLLOW FIRE BRICK Co., Woodbridge, N. J. *Booth 680*—Firebrick and refractories.

N

NASH ENGINEERING Co., So. Norwalk, Conn. *Booth 66*—Jennings-Hytor vacuum and condensation pumps for heating systems, compressors, pumps and sewage ejectors.

NATIONAL ASSOCIATION OF STATIONARY ENGINEERS. *Booth 82.*

NATIONAL COMPANY, Boston. *Booth 76*—Water column illuminators.

NATIONAL ENGINEER, Chicago. *Booths 82-83.*

NATIONAL MAGNESIA MFG. Co., New York. *Booth 717*—Insulating products.

NATIONAL REGULATOR Co., Chicago. *Booth 671*—Pressure regulators and reducing valves.

NATIONAL TUBE Co., Pittsburgh, Pa. *Booths 8A and 8B*—Seamless tubing, boiler tubes, pipe and flanges.

NAUGATUCK MFG. Co., Naugatuck, Conn. *Booth 481*—Seamless copper and nickel floats for tanks, receivers, etc.

NEEMES FOUNDRY, INC., Troy, N. Y. *Booth 93*—Operating sections of shaking and dumping grates and a hand operated stoker.

NELSON HERMAN CORP., Moline, Ill. *Booths 608-609*—Unit heaters and invisible type radiators with wedge coil sections.

NICHOLSON, W. H. & Co., Wilkes-Barre, Pa. *Booth 92*—Steam traps.

NILES GEAR Co., New York City. *Booths 457-458*—Samples of various types of gears including spur, single helical and herringbone types.

NORMAN-HOFFMAN BEARING CORP., Stamford, Conn. *Booths 279-280*—Complete line of ball, roller and thrust bearings. Several models illustrating the proper method of applying ball bearing in power transmission machinery.

NORTHERN EQUIPMENT Co. *Booth 19*—"Copes" feed-water regulator and pump governors.

NUTTALL, R. D. Co., Pittsburgh. *Booth 684*—Speed reducers and flexible couplings.

O

OAKITE PRODUCTS, INC., New York City. *Booths 734-735*—Charts, blueprints and illustrations showing the applications of Oakite products in cleaning oil coolers, surface condensers and other similar equipment.

OBERMAYER, S., Co., Newark, N. J. *Booth 260*—High-temperature cements and monolithic firebrick material, refractory shapes for special service conditions.

OLSON, TINIUS TESTING MACHINE Co., Philadelphia. *Booth 318*—Testing machines for hardness and ductility also dynamic balancing machines for revolving parts.

OTIS ELEVATOR Co., New York City. *Booth 57*—Commercial steel castings made by the electric furnace process.

OXWELD ACETYLENE Co., New York City. *Booth 266*—Oxweld cutting and welding equipment, stationary and portable acetylene generators, welding rods and fluxes.

P

PEABODY ENGINEERING CORP., New York City. *Booth 47*—Peabody, fuel oil, gas and pulverized coal-burning equipment, including Toronto type burners and insulated front burner.

PEERLESS UNIT VENTILATING Co., INC., Long Island City, N. Y. *Booths 747-748*—Unit heaters.

HENRY PELS & Co., New York City. *Booths 499-500*—Quadruple combined punch and shear and concrete reinforcing bar cutters.

PENNSYLVANIA CRUSHER Co., Philadelphia, Pa. *Booths 286-287*—Working models of Bradford coal breaker and armoframe coal crushers.

PENNSYLVANIA PUMP & COMPRESSOR Co., Easton, Pa. *Booths 522-523*—Air compressor, motor-driven, working model of air-lift pump and high-pressure boiler feed pump.

PERMUTIT Co., THE, New York City. *Booths 3 and 28*—Model of water softening and filtering equipment such as is used in industrial plants. Also "Ranarex" CO_2 recorder for gas density, ammonia gas, etc.

PHILADELPHIA GEAR WORKS, Philadelphia, Pa. *Booth 10*—Complete line of spur- and worm-gear reduction units.

PITTS & KITTS MFG. & SUPPLY Co., New York City. *Booth 451*—A complete line of Klipfel Mfg. Co. products including high- and low-pressure steam traps, feedwater and damper regulators, reducing valves, safety water columns, gage cocks, etc.

PITTSBURGH PIPING & EQUIPMENT Co., *Booths 420-421*—Valves and samples of piping for high pressures and temperatures. Samples of wrought-steel welded headers, with welded-in nozzles and Sargol weld joint.

PITTSBURGH VALVE, FOUNDRY & CONSTRUCTION Co., Pittsburgh, Pa. *Booth 4*—Motor-and cylinder-operated gate valves, high-pressure valves, fittings and piping.

PLIBRICO JOINTLESS FIREBRICK Co., Chicago, Ill. *Booth 93*—Plibrico furnace lining and monolithic furnace construction and the flexo-anchor for securing the Plibrico wall to the common brick.

POOLE ENGINEERING & MACHINE Co., Baltimore, Md. *Booth 467*—Poole flexible gear-type coupling and speed reduction units.

PORTER-CABLE MACHINE Co., Syracuse, N. Y. *Booth 667*—Hand sander, Kwicksaw and disk sander and grinder.

POWER SPECIALTY Co., New York. *Booth 92*—Foster superheaters and economizers.

POWELL Co., WM. THE, Cincinnati, Ohio. *Booths 494-495*—Complete line of bronze, iron, steel, globe angle, check, gate and safety valves, oilers, lubricators, water gages, fusible plugs, etc., also a line of steel valves (hand and electric operated) for pressures from 150 to 900 pounds.

POWER, New York City. *Booth 42.*

POWER AGE, Toronto, Canada. *Booth 624.*

POWER HOUSE, Toronto, Canada. *Booth 753.*

POWER PLANT ENGINEERING, Chicago. *Booth 99.*

POWERS REGULATOR Co., Chicago. *Booth 640*—Temperature and humidity control apparatus, steam traps and reducing valves.

PRAT-DANIEL CORP., New York. *Booth 656*—Adjustable soot blower for plate-type heaters, also stream-line stack for high draft.

PRATT & CADY Co., Bridgeport, Conn. *Booth 48*—High- and low-pressure globe and gate valves.

PREFERRED UTILITIES Co., INC., New York City. *Booths 304-305*—"Ray" rotary fuel-oil burner, an electrically driven fuel-oil burner with steam-actuated oil and

air controls, also various sizes of the small Ray automatic fuel-oil burner.

PULMOSEN SAFETY EQUIPMENT CORP., Brooklyn, N. Y. *Booth 743*—Helmets, masks and respirators.

PYRAMID IRON PRODUCTS CORP., New York City. *Booths 306-307* — Pyramid grates and details of settings.

PYROMETER INSTRUMENT CO., New York. *Booth 501* — Optical-and radiation-type pyrometers.

Q

Q-P SIGNAL CO., Needham Heights, Mass. *Booth 666* — Ratchet pipe flange wrench.

QUASI-ARC, INC., New York. *Booth 606.*

QUEEN'S RUN REFRACTORIES CO., INC., Lock Haven, Pa.—*Booth 569*—Standard shape brick for lining boiler furnaces, special roof and bung brick for heating and reverberatory furnaces. Number of intricate special shapes for furnace repairing.

QUIGLEY FURNACE SPECIALTY CO., New York City. *Booth 89*—"Hytempite" for bonding firebrick and patching furnace linings; acid-proof cement for bonding and surfacing masonry and the Quigley refractory gun for furnace repairing.

R

RAMSEY CHAIN CO., INC., Albany, N. Y. *Booths 292-293*—Ramsey silent chain drives.

RAWLPLUG CO., INC., THE, New York City. *Booth 668*—Rawlplugs and a demonstration of their use.

RAY, W. S. MFG. CO., San Francisco. *Booth 304*—Fuel-oil pumping and burning equipment.

RAYMOND BROS. IMPACT PULVERIZER CO., Chicago.—*Booth 23*—Coal pulverizers.

READING IRON CO., New York City. *Booth 230*—Samples of wrought-iron piping and boiler tubes.

READING STEEL CASTING CO., Bridgeport, Conn. *Booth 48* — Iron-body bronze-mounted valve and a cast-steel monel-trimmed gate valve equipped with motor control, also cast-steel gate valves with rustless steel trim.

REED AIR FILTER CO., INC., Louisville, Ky. *Booth 209-A*—Automatic air filter, compressor filter, radiator cabinets and copper heating unit.

REEVES PULLEY CO. *Booth 26*—Variable-speed transmission equipment.

RELIANCE ELECTRIC & ENGINEERING CO., THE, Cleveland, Ohio. *Booths 620-621*—A water- and dust-tight direct-current motor for driving stokers and other equipment subject to coal dust, and moisture conditions, an alternating-current motor with stator insulated to give protection against acids, dirt, steam and water also standard sleeve-and ball-bearing motors.

RELIANCE GAUGE COLUMN CO., THE, Cleveland, Ohio. *Booth 81* — Sectional samples of electric alarms, valves and gage cocks. Sectioned and trimmed water columns for 250, 450 and 750 lb. pressure. For the latter pressure the column is made of extra-heavy all forged-steel and equipped with chrome-silicon seats and disks, gage cocks and water gage for 1,500 lb.

REPUBLIC FLOW METERS CO., Chicago. *Booth 6*—Complete line of Republic instruments including flow meters for steam, water, air and gases; boiler meters, pyrometers, indicating and recording CO_2 meters, draft indicators and recorders, coal meters, combination steam-flow CO_2 recorders liquid level and pressure recorders and indicators; also a new type boiler meter panel including a multiple recorder which will record six records simultaneously.

RICHARDSON SCALE CO., Clifton, N. J. *Booths 283-284* — Apron-feed coal scales and hand weighing lorry.

RILEY STOKER CORP., Worcester, Mass. *Booths 78-79*—New Riley super-stoker, improved Atrita unit coal pulverizer, flare-type pulverized coal burner and a new Jones stoker unit.

ROBINSON, JOHN R., New York City. *Booth 650*—Pipe gaskets.

ROBERTS STEAM SPECIALTY CO., Cleveland, Ohio. *Booth 711*—Forged-steel water columns seamless copper and laminated steel floats, water-column adapter for changing a vertical glass to an inclined position, gage light and weighted-lever gage locks.

ROCHESTER ELECTRIC PRODUCTS CORP., Rochester, N. Y. *Booth 655*—Diverter-pole generators.

ROGERS, F. L. & CO., Chicago. *Booth 694*—"Wodack" electric hand saw mortiser and router.

ROLLWAY BEARING CO., Syracuse, N. Y. *Booth 514*—Line of radial and thrust roller bearings for heavy-duty equipment, also bearing housing for standard electric motors.

ROME BRASS RADIATOR CORP., New York. *Booths 669-670*—Radiators and unit heaters.

ROTO CO., Hartford, Conn. *Booth 11*—Boiler-tube cleaners, hand-hole seat scrapers, cap cleaning and reseating machine.

RUGGLES COLES ENGINEERING CO., New York City. *Booth 26*—Cylindrical driers for coal and other materials.

RUGGLES-KLINGERMANN MFG. CO., Salem, Mass. *Booths 558 - 559 - 560* — Stepaction regulators, pressure regulators and motor-operated regulators for control of pressures and temperatures.

RUTHS ACCUMULATOR CO., INC., New York City. *Booth 91*—Photographs of accumulator systems also important parts, such as steam governors and controls.

S

SARCO CO., INC., New York City. *Booth 33*—Thermostatic steam traps, temperature regulators and strainers. Also heating specialties for vacuum, vapor and pressure heating systems, including packless inlet valves and thermostatic radiator return traps.

SAUERMAN BROS., INC., Chicago, Ill. *Booths 520-521*—Equipment for storing and reclaiming coal.

S. C. REGULATOR MFG. CO., Fostoria, Ohio. *Booth 696*—S. C. Feed-water regulators and pump governors, drainage controls and a master-control for pressure regulating and reducing.

SCHADE VALVE MFG. CO., Philadelphia. *Booth 76*—Reducing valves and regulators.

SCHUTTE & KOERTING CO., Philadelphia, Pa. *Booths 334-335.*—Double-duty boiler feed injectors, reducing valves, multi-jet condensers, radi-fin tube generator air cooler. Spur and herringbone rotary gear pumps, "Klinger" piston valves, and the Helpbringer electric control for motor-operated reducing valves.

SCOVILLE MFG. CO., Waterbury, Conn. *Booth 69* — Cup-drawn Admiralty and Muntz metal condenser tubes, general brass products such as sheet, rod, wire, tubing, and forgings.

SHAFER BEARING CORP., New York. *Booth 703*—Roller bearings, pillow blocks and hangers.

THE SHARPLES SPECIALTY CO., Philadelphia, Pa. *Booth 92*—A presuratite super-centrifugal for purification of fuel oil, a portable machine for dehydration of transformer oil, a machine in cross-section to show the operating principle.

SHAW, A. W., CO., Chicago. *Booth 3-N* —Sweets Engineering Catalog System.

SHAW, B. F., CO., Wilmington, Del. *Booth 496*—Bell-turned and recessed joint pipe.

SHEPHERD ELECTRIC CRANE & HOIST CO., Montour Falls, N. Y. *Booth 632*—Drawing and photograph of Shepherd line of hoisting equipment.

SILENT HOIST WINCH & CRANE CO., Brooklyn. *Booth 687*—Industrial hoists, winches and crane.

JOHN SIMMONS CO., New York City. *Booth 519*—Valves and fittings.

SIMPLEX OIL HEATING CO., New York. *Booth 652*—Oil heating equipment.

SIMPLEX VALVE & METER CO., Philadelphia, Pa. *Booth 76*—Simplex hot- and cold-water meters of the indicating recording and totalizing types.

SKEEN, D. H. & CO., Chicago. *Booth 31*—Mercon regulators and Henszey deconcentrator.

S.K.F. INDUSTRIES, INC., New York City. *Booths 332-333*—S.K.F. ball bearings, including radial and thrust, single- and double-row bearing, hangers and pillow blocks.

SKIDMORE CORP., Chicago, Ill. *Booth 456* —Vacuum pumps for condensing and heating system.

SMIDTH, F. L., & CO., New York City. *Booths 281-282*—Lenix short-center belt drive with a demonstration of the power lost through belt slip and the action of the Lenix drive in preventing slip.

SMITH & SERREL, Newark, N. J. *Booth 85*—"Francke" flexible couplings.

SMOOT ENGINEERING CORP., New York City. *Booths 417-418-419*—Smoot centralized system of combustion control in operation and a new gas density recorder.

SNAP-ON WRENCH CO., Chicago, Ill. *Booth 449*—Wrenches and tools.

SOUTHERN POWER JOURNAL, Atlanta, Ga. *Booth 10.*

SOWDON & GREENE, New York City. *Booth 76*—Ernst water columns and gages, National water-column illuminators, Schade steam and water specialties, Strong-Scott coal pulverizers.

THE SPENCER TURBINE CO., Hartford, Conn. *Booths 452-453*—Centrifugal compressors and vacuum cleaning apparatus for industrial purposes.

SPRINGFIELD BOILER CO., Springfield, Ohio. *Booth 32*—Parts of the Springfield water-tube boiler, showing details of construction.

SQUIRES, C. E., CO., Cleveland. *Booth 663*—Squires steam traps and reducing valves.

STANDARD STEEL & BEARINGS, INC., Plainville, Conn. *Booth 336*—This company will feature aviation motors and the exhibit will include a Wright Whirlwind radial air-cooled motor, Pratt & Whitney "Wasp" motor and a Curtiss D-12 motor.

STAYNEW FILTER CORP., Rochester, N. Y. *Booths 571-572*—Oil filters and purifiers.

STEACY-SCHMIDT MFG. CO., York, Pa. *Booth 26*—Steam specialties.

STERLING ENGINE CO., Buffalo, N. Y. *Booths 446-447*—Commercial type engines for driving pumps, generators, etc.

STIMMEL WINCH MACHINE WORKS, New York. *Booth 603.*

STOCKHAM PIPE & FITTINGS CO., Birmingham, Ala. *Booth 472.*

STRAND, N. A., & CO., Chicago. *Booth 700.*

B. F. STURTEVANT CO., Boston, Mass. *Booths 411-412-413-414 and 483-484*—Tu-

bular air heater, plate-type air heater, turbovane forced-draft fan, turbo undergrate blowers, unit heaters and multi-stage compressor.

STURTEVANT MILL CO., Boston. *Booth 604*—Small coal grinders for testing purposes.

SUMET CORP., New York City. *Booth 515*—Sumet metal bearings.

SUNLIKE ILLUMINATING CO., New York. *Booth 460*—Method of illuminating boiler rooms, instrument boards and switch panels to minimize glare.

SUPERHEATER CO., THE, New York City. *Booth 56*—Enlarged detailed layouts of boilers with Elesco super-heaters, also a section of an eccentric superheater header for 800 lb. pressure.

THE SWARTWOUT CO., Cleveland, Ohio. *Booths 696-697*—Centrifugal type separator for steam, oil and air, ventilators, low-pressurre float-type and high-pressure bucket-type traps, also S.-C. feed-water regulators and pump governors.

SWEET & DOYLE FOUNDRY & MACHINE CO., Troy, N. Y. *Booth 477*—Folding machines.

SWORD-SILENT OIL BURNER CORP., Philadelphia. *Booth 699*—Domestic and industrial oil burners.

SWORD & KIMBER, Philadelphia. *Booth 699*—Oil burners.

T

TAGLIABUE, C. J., MFG. CO. *Booth 59*—A feature of this exhibit will be the steam and air operated controllers for temperature and pressure. Mono duplex recorder for indicating and recording the percentage of CO and CO_2 in flue gases. Other instruments shown will be recording and indicating dial thermometers, recording pressure and vacuum gages, automatic controllers for temperature, pressure and humidity, viscosimeter, hydrometers, etc.

W. O. & M. TALCOTT, INC., Providence, R. I. *Booth 723*—Belt fasteners.

TAYLOR INSTRUMENT COMPANIES, Rochester, N. Y. *Booth 507*—Industrial thermometers of different types, self-acting and air-operated temperature controls for use on desuperheaters, bleeders lines, etc., indicating and recording thermo-electric pyrometers, mercury columns, vacuum and absolute pressure gages, distance-reading electric transmitting thermometers and direct-reading superheat thermometers.

TEMPLETON BROS., Boston. *Booth 274*—Boiler feed and pumping traps.

THE TERRY STEAM TURBINE CO., Hartford Conn. *Booths 207-208-209*—Herringbone-type reduction gear. Flexible shaft couplings, rotor of a 500 kw. multi-pressure turbine and the Terry turbine stoker drive.

TEXAS CO., New York City. *Booths 641-642*—Samples of Texas products.

THATCHER STOKER CO., Everett, Mass. *Booth 468*—Step-type over feed stoker.

TIDE WATER OIL SALES CORP., New York City. *Booth 15-A*—Petroleum products.

TIMKEN ROLLER BEARING COMPANY, Canton, Ohio. *Booth 2-N*—Full line of Timken bearings for all kinds of industrial machinery.

TOLEDO PIPE THREADING MACHINE CO., Toledo, Ohio. *Booth 720*—Complete line of pipe threading and cutting machines.

TOLEDO SCALE CO., Toledo, Ohio. *Booths 724-725*—Industrial scales.

TOPPING BROS., New York City. *Booths 512-513-524-528*—Products of the manufacturers which they represent.

TORCHWELD EQUIPMENT CO., Chicago, Ill. *Booth 525*—Complete line of oxy-acetylene equipment consisting of gas cutting and welding equipment, gas pressure regulators and gas welding supplies.

TRILL INDICATOR CO., Corry, Pa. *Booth 746*—Outside-spring and continuous card indicators, rotating check valves.

TRI-LOK CO., Pittsburgh, Pa. *Booths 401-402*—Tri-Lok steel grating and treads.

TRIPLEX MACHINE TOOL CO., New York City. *Booths 646-647-661*—Boring, threading, gear hobbing and bench filing machines.

U

UEHLING INSTRUMENT CO., Paterson, N. J. *Booth 45*—Complete line of CO_2 recorders and waste meters, vacuum recorders, combined barometer and vacuum recorders and pyrometers. Also automatic control apparatus.

THE UNISHEAR CO., INC., New York City. *Booths 475-476*—Several models of unishears.

U. S. ELECTRICAL TOOL CO., Cincinnati, Ohio. *Booth 700*—Electric drills, bench grinders and buffers.

V

VIKING PUMP CO., Cedar Falls, Iowa. *Booth 714*—Rotary pumps for various services.

VINCENT-GILSON ENGINEERING CO., New York. *Booth 17*—Products of the Diamond Power Specialty Corp. and the Andrews-Bradshaw Company.

HENRY VOGT MACHINE CO., Louisville, Ky. *Booths 269-270*—Drop-forged steel valves and fittings for high pressures.

THE VULCAN SOOT CLEANER CO., Du Bois, Pa. *Booth 19*—Self-contained valve operating head, ratchet operating soot-cleaner head and high-temperature heat-resisting elements.

W

WAHLSTROM TOOL CO., Brooklyn, N. Y. *Booth 427*—Automatic chucks and tapping attachments.

WAILES DOVE-HERMISTON CORP., New York City. *Booths 261-262*—Paints and enamels for metal surfaces.

WAITE & DAVEY CORP., INC., Long Island City, N. Y. *Booth 58*—Air-cooled furnace arches and blocks.

WALLACE, J. D. & CO., Chicago. *Booth 692*—Portable direct motor-driven woodworking machinery.

WALSH-WEIDNER BOILER CO., Chattanooga, Tenn. *Booth 72*—Seamless forged-steel sectional headers for 650 and 1,400 lb. longitudinal section of a 54 in. diameter steel boiler drum for 450 lb., also a section of the water wall for boiler furnaces.

WALWORTH CO., Boston, Mass. *Booths 308-309-310-311*—Valves for steam service in pressure from 150 to 1,350 lb., gate valve of Sigma steel body and Sigmalloy trim, and at Booth 44-A a complete line of Walworth pipe tools.

WAPPAT GEAR WORKS, Pittsburgh. *Booth 772*—Portable electric wood-working tools.

WARREN STEAM PUMP CO., Warren, Mass. *Booth 231*—Reciprocating, single- and multi-stage centrifugal pumps, including a 4 in. single-stage double-suction pump for 3,600 r.p.m.

WARREN WEBSTER & CO., Camden, N. J. *Booths 225-226*—Modulation system of steam heating, packless valves, heaters, boiler return and vent traps. Also Webster "series 78" traps for process steam pressures.

WATTS REGULATOR CO., Lawrence, Mass. *Booth 39*—Reducing valves, pump governors, hydraulic damper regulators and monel-metal pilot-operated auxiliary pressure regulators.

WAVE CUT FILE TOOL CORP., New York. *Booth 669.*

WELDING ENGINEER, Chicago, Ill. *Booth 442.*

WESTINGHOUSE ELECTRIC & MANUFACTURING CO., Pittsburgh, Pa. *Booths 564-565-566*—New high-pressure multi-stage boiler-feed pump, 3-stage oil-line pump, duplex and triplex enclosed crank-case pumps, 200-kw. geared-turbine generators and a 3-kw., 125-volt turbine-generator unit.

WESTON ELECTRICAL INSTRUMENT CO., Newark, N. J. *Booths 510-511*—Portable and switchboard electrical indicating instruments and an improved electric speed indicator.

WHEELER CONDENSER & ENGINEERING CO., Carteret, N. J. *Booth 64*—Steam-jet vacuum pumps, evaporators, Feed water-heaters and cooling towers.

C. H. WHEELER MFG. CO., Philadelphia, Pa. *Booth 77*—Sectional model of a two-stage radojet air pump, with inter and after condenser; a three-stage radojet with two inter condensers for producing a high vacuum, also Leach Fracto Control Condenser.

THE WHITNEY MFG. CO., Hartford, Conn. *Booth 250*—Silent and roller chain transmissions.

THE WICKES BOILER CO., Saginaw, Mich. *Booth 285*—Views of boilers in process of construction and actual installations. A section of Wickes single joint header and a model of the new three-drum curved-tube boiler.

WILLIAMS TOOL CORP., Erie, Pa. *Booth 661*—Pipe threading machines.

L. J. WING MFG. CO., New York City. *Booth 61*—Turbine blowers for stokers and hand-fired plants, motor-driven blower for low-pressure heating boilers, speed regulators for controlling the speed of motor-driven blowers, low ceiling type, feather-weight unit heater and a scruplex exhauster.

T. B. WOOD'S SONS CO., Chambersburg, Pa. *Booths 479-480*—Line of power transmission appliances including automatic belt contactors, flexible couplings and ball-bearing hanger boxes.

WORTHINGTON PUMP & MACHINERY CORP., New York City. *Booths 487-488-489*—Multistage hydraulically balanced boiler-feed pump of the volute type for high pressures. "Axiflo" sump pump and vertical and horizontal single-stage compressors.

WRIGHT-AUSTIN CO., Detroit, Mich. *Booth 255*—Line of steam specialties including weighted trycocks, water gage with glass replacing union, Kleervu gage glass protector and Airxpel bucket trap.

WRIGHT MFG. CO., Lisbon, Ohio. *Booth 698*—Industrial hoist and trolleys.

X

X-LABORATORIES, New York City. *Booth 259*—X Liquid for repairing leaks in boilers, etc.

Y

YALE & TOWNE MFG. CO., Stamford, Conn. *Booths 622-623*—Electric industrial high- and low-lift trucks from 2 to 5 ton capacity, tractors and trailers also differential, screw-geared and spur-geared hoists, electric chain hoists and cranes.

YARNALL-WARING CO., Philadelphia, Pa. *Booths 7A and B*—Complete line of Yarway blow-off valves for pressures up to 1,350 lb. Involute spray nozzles and fittings. High- and low-pressure water columns with Yarway "Sesure" inclined water gage also Lea V-Notch meter, hydraulic valves and pipe clamps.

EDITORIALS

F. R. LOW, *Editor*

Serving the Industries

IN THIS issue there are discussed problems incident to the furnishing of power and process steam in several major industries. The authors in each case speak from intimate knowledge of their respective industries gained through consulting or operating contact.

Perhaps the most impressive feature of a group of presentations of this sort is the fact that, however widely the production processes may differ, the problems of supplying power and heat are much the same everywhere. Solutions to these problems vary with local circumstances, but the basic principles are the same.

The power engineer should study such material intently. He may be serving a tannery or a paper mill, and yet find in a rubber or sugar plant the solution of his most pressing difficulty.

The object of this issue is to help the reader attain a broader view of the entire field of power and heat, generation and utilization, for the power engineer who desires to keep in the front rank must extend his knowledge beyond the confines of the engine and boiler room and be prepared to accept the responsibility of meeting the demands of the production department.

Power-Plant Materials for High Temperatures and Pressures

THE tendency to the upper limit in speed, temperature and pressure has given a new significance to metallurgy in power-plant practice.

For turbine blades metal is necessary that has the strength to withstand the severe tensile stresses set up by angular velocities that had no parallel in the steam plant of the 1900's, ductility to resist breaking under vibration, hardness to resist the erosive action of high velocity steam, often laden with moisture and grit.

For the seats, disks and trimmings of valves and steam appliances a metal is required that will rigidly hold its shape under severe changes of stress and temperature, and which at high temperatures will not roughen up or gall when in moving contact. While temperature seems the first consideration in this respect, the accepted high limit of temperature has remained at about 750 degrees for sometime, while pressures have soared. A metal that would function admirably at 750 degrees, 150 pounds, might prove inadequate at this temperature under the higher stresses due to an increase of pressure.

The industry is looking, too, for a metal suitable for the drums of high-pressure boilers. With the 55,000-pound steel now permitted for this purpose, a thickness of some four inches was required for the walls of the 48-inch drums of the 1,200-pound boilers at Weymouth. Alloy steels of twice this tensile strength, greater resistance to impairment by high temperature and a high degree of ductility have been produced. If they could be furnished at a price that would permit their use for this and similar purposes, reducing the required thickness by one-half, new possibilities would be opened up in boiler construction.

Maintenance Cost of Pulverized Coal Equipment

IS TOO much stress being placed on the cost of maintaining pulverized fuel equipment as compared with other operating costs? Ordinarily, there is a difference of only three or four cents per ton of coal pulverized between the cost of maintaining mills of various types, grinding various grades of bituminous coal, and this difference might easily be overbalanced by a small change in one or more of the many other variables involved. One or two per cent change in boiler efficiency will in most cases equal the difference in maintenance between any two mills. With coal costing five dollars a ton, a change in efficiency from eighty to seventy-nine per cent increases the cost a bit over six cents a ton.

There is a wide spread between the power consumption of various mills. With power charged at a cent per kilowatt-hour, three or four kilowatt-hours per ton difference in power consumed to grind coal would probably wipe out the advantage of a mill having low maintenance cost. Of course a mill having both low maintenance cost and low power consumption would have a double advantage, and there is no reason to suppose that high power demand accompanies low maintenance cost; indeed, the reverse is just as likely to be the case.

Low maintenance costs are obviously desirable, but perhaps there is a tendency to over-emphasize this feature and to neglect others that are at least equally important.

The application of pulverized fuel is passing through a period of growth and is doubtless suffering from growing pains. The multiple-retort underfeed stoker went through much the same stages years ago and was sub-

ject to much the same type of critical comment. Today the question of stoker maintenance is seldom raised as a serious obstacle, nor is the comparative power consumption of various types of stokers given very serious consideration in the choice of equipment. This is doubtless because the characteristics of the leading types of stokers are well known to engineers, who have become accustomed to the fact that if labor is to be saved and if efficiency is to be improved, machinery must be consumed as well as fuel.

The underfeed stoker is today undergoing great advances in design, and in the intelligent application to more difficult situations, and while these changes are probably as great as the changes being made to pulverized fuel equipment, they are not noised about so much, perhaps because they are more of a normal growth based on long experience along a more clearly indicated line of development than is the case with coal pulverizing equipment. A new device is naturally subjected to more searching scrutiny than an old familiar friend whose limitations are more generally known. It is important that in forming judgment on new equipment the engineer keep his feet on the ground and his weight balanced squarely on both of them at once. A firm footing and an even balance are essential to sound engineering thinking.

Relation of Machine to Motor Speed

WHEN applying a motor to a machine, the speed relation between the motor shaft and the drive shaft of the driven machine is an ever present problem. As those who are familiar with motor applications know, t is a problem that is frequently difficult to solve satisfactorily without using special equipment. Under present conditions the speed of the drive shaft of the driven nachine is apparently frequently more a matter of fancy on the part of the designer than an attempt to have it bear some relation to the speed of the motor to be used.

Out of this condition have developed requirements for pulleys, gears and sprockets in sizes of an almost endless variety. This is only another one of the sources of waste due to the lack of proper standards. On December ninth there will be held a meeting in the Engineering Societies Building, New York City, by the American Engineering Standards Committee to determine if there shall be set up a national system of standard speeds for driven machinery. No doubt, to establish such a system of standards will involve many difficulties, but the benefits to be derived warrant its careful consideration.

Standard motor speeds have been adopted by the Electric Power Club, now part of the National Electrical Manufacturers Association. Direct-current motors can be designed for any speed within the physical limits of the material, but the standards have been adopted to correspond to the speed of alternating-current motors, which are fixed by the frequency of the circuit. The fact that the speed of alternating-current motors is fixed in definite steps by the relation of the frequency of the circuit and the number of poles in the motor, makes a consideration of an advantageous speed for the drive shaft of the machine of serious moment.

To meet the drive-shaft speed limitations of the driven machine, in some cases a slow-speed motor has been used, with its higher cost and low power factor and efficiency and other undesirable characteristics. In other cases complicated and expensive mechanical drives have been necessary, where, if consideration had been given to the motor's speed when the machine was designed, a much more desirable drive might have been worked out at that time.

There are certain limitations in motor speeds and in the means available for connecting the motor to the driven machine. Ignoring of these limitations by the designer of the driven machine, has resulted in some expensive and unsatisfactory drives. Although applying the drive to a machine may not be a problem in which the builder of the machine is directly interested, indirectly, he is vitally interested, since the drive may cause an otherwise satisfactory machine to give a lot of trouble. This is one thing for the motor and the machine manufacturers to keep in mind when they meet to consider this problem. They all have a common interest in delivering equipment to their customers that will give satisfaction.

An Inspiration and a Mine of Information

BEFORE another issue of *Power* leaves the presses, one more annual meeting of the American Society of Mechanical Engineers will be under way. More and more each year the meetings of this organization become indispensable to the engineer who desires to keep abreast of progress in his profession. Papers on power and its various applications occupy the major attention of this gathering. This year alone such topics as central station power, industrial power, pumping, boiler feed water, fuels, refrigeration, oil and gas power, and lubrication are on the program, with more than one paper apiece.

For those who cannot attend, this meeting will be reported in abstract in these columns the week following the meeting. Later, the papers will be available in full in the publications of the society. But let us urge upon all who can possibly do so, even at a considerable sacrifice that they attend. To hear these papers in the company of those who are like-minded; to take part in the discussion that they arouse; and, perhaps most important of all, to renew old friendships and make new ones, is an inspiration and a refreshment that stays with one throughout the whole ensuing year.

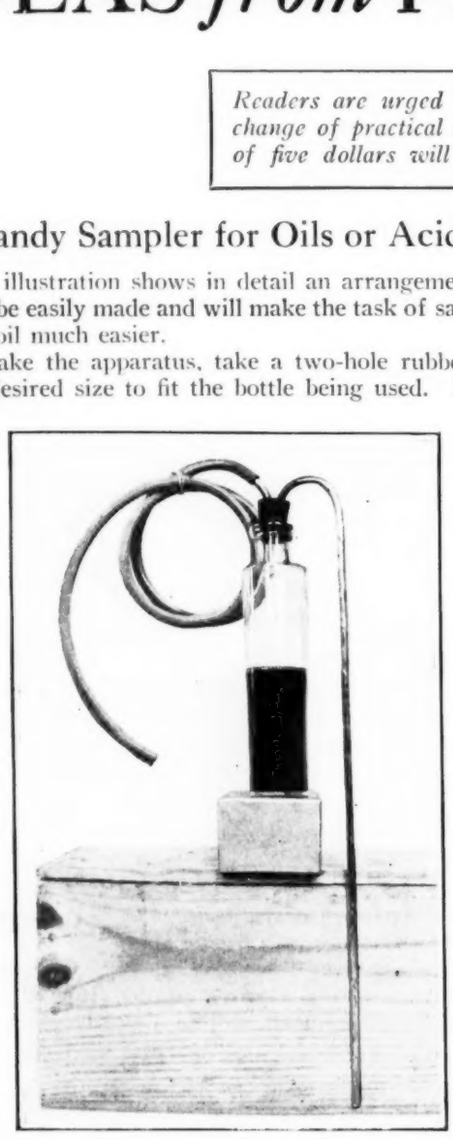
IDEAS *from* PRACTICAL MEN

Readers are urged to use this department for the exchange of practical operating information. A minimum of five dollars will be paid for contributions accepted

Handy Sampler for Oils or Acids

THE illustration shows in detail an arrangement that can be easily made and will make the task of sampling turbine oil much easier.

To make the apparatus, take a two-hole rubber cork of the desired size to fit the bottle being used. Bend a



Assembly of oil sampler

piece of $\frac{3}{16}$-in. copper tubing as shown in the photograph and put the short end into one hole of the cork. The tubing should be long enough to go into the oil stream from which the sample is to be drawn. In the other hole insert a short piece of the same size copper tubing, the free end to be attached to a piece of rubber tubing. Both pieces of copper tubing are fitted just flush with the bottom of the rubber cork.

To use the apparatus, insert the rubber cork tightly into the bottle, place the long end of the copper tubing into the oil stream. Then exhaust the air from the bottle by sucking at the free end of the tubing. The oil will immediately pour into the bottle. When the desired quantity is obtained, take the rubber tube from the mouth and the cork from the bottle. It is always a good plan to blow into the rubber tubing after the long end of the copper tubing is out of the oil and before the cork is removed from the bottle. This blows the oil out of the copper tubing and it will not drip.

This apparatus can be used to draw off samples of other liquids, but if acids are to be sampled, use glass tubing instead of copper. This sampler is much better than a siphon as the user does not get the liquid into his mouth.

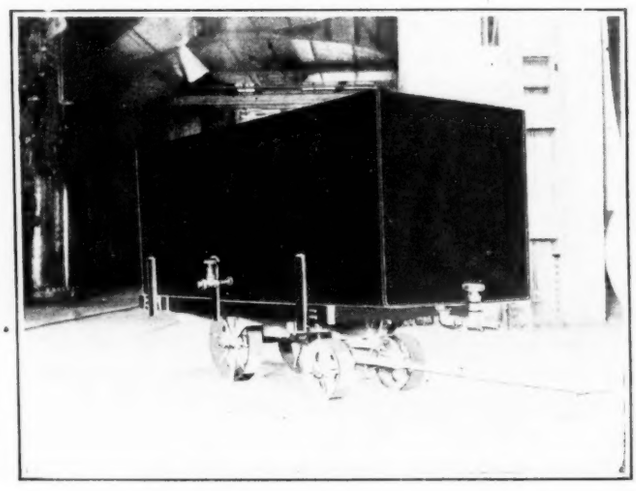
F. R. RAWSON.

Denver, Colo.

Cleaning Oil Coolers

OIL coolers, like any other power plant apparatus, must be kept clean to obtain efficient, uninterrupted and economical operation. This is appreciated to a marked degree in the Essex Power Plant of the Public Service Electric & Gas Company of New Jersey, where a specially designed portable cleaning equipment has been constructed for this purpose.

The tank of this equipment, which is made of $\frac{1}{4}$-in. boiler plates with welded seams, is 37 in. wide, 36 in.



Portable Cleaning Equipment for Oil Coolers

high and 7 ft. 6 in. long. Two $\frac{5}{8}$x3-in. flat plates welded on each side of the tank project 4 in. below the base and slip over the truck frame into retaining guides when the tank is in its position on the truck. These projections and guides prevent the movement of the tank on the truck during transportation and provide for its ready removal without resorting to any unbolting process.

The truck frame is made from 2x4-in. well-seasoned oak timbers, is bolted together and mounted upon two

1½-in. square steel axles. Wheels of 18-in. diameter and 3-in. face are installed on the rear axle, whereas wheels of 12-in. diameter and 3-in. face are installed on the front axle. A ¾-in. round T-handle and a suitable fifth wheel over the front axle provide for easy movement to any location desired.

Referring to the illustration, it will be noted that tnere is a short piece of pipe with a valve projecting from the bottom of the tank. This connection is made of 1-in. pipe and is used for filling the tank with clean cold water and withdrawing the dirty water after completion of the cleaning process. The ½-in. connection at the left is connected to a piece of ½-in. pipe on the inside of the tank extending its entire length. This pipe is plugged on both ends and perforated with ⅛-in. holes every two inches. It is used for the admission of steam to heat the solution to the boiling point. The overflow is taken care of by a 1-in. outlet on the back of the tank about 6 in. from the top.

Three 3x12-in. oak yokes are installed in the bottom of the tank to provide a suitable cradle for the support of the bundle of coils during the cleaning period.

The procedure for cleaning coils is as follows: The bundle of coils is placed on the cradle in the tank and covered with cold water obtained from the 1-in. cold-water inlet. Ten pounds of Okite is added to this water. Steam is admitted through the ½-in. steam inlet, and the temperature of the solution is raised to the boiling point, which is continued for 12 hours. At the end of this time the Okite solution and the sediment are drawn out through the 1-in. cold water pipe. After the bundle of coils is rinsed with clean cold water and drained for one-half hour, it is removed from the tank, blown out with compressed air, wiped off with clean rags and allowed to dry.

This cleaning process is performed approximately every four months and has been found entirely satisfactory. F. P. VREELAND.

New York.

Beware of Low Flue-Gas Temperature

WHEN the average engineer finds the flue-gas temperature lower than the average, he merely pats himself on the back and sometimes tells his engineer friends about it with pride. But if it were to rise suddenly he would investigate at once. In fact, the low temperature of flue gas should be investigated as promptly as high temperature, as other things than high boiler efficiency can cause low gas temperature

In an oil-burning installation on shipboard the second engineer took pains to show me that you could comfortably hold your hand on the smokebox doors and said, "Not much heat being wasted up the stack around here." I noticed that no smoke was being made and that one inch of draft was being carried. The oil pressure usually carried at the burner was 155 lb., which would drop when the steam pressure went high enough to operate the fuel pump governor.

As an experiment I cut the draft to one-half inch and noticed that the usual speed could be maintained at twelve knots and 88 propeller revolutions with but 140 lb. pressure at the burner. This would drop to 130 at times, and the fuel pump ran noticeably slower. But the second engineer ignored these evidences of economy and proceeded to show me that the smokebox doors were so hot he could not hold his hand there. He likewise claimed that with one-half inch draft he had to blow soot off the tubes twice a week, but with one inch draft the tubes were swept clean. I had a hard time convincing him that more heat was wasted up the flue when heating two pounds of air to 400 deg. than when heating one pound to 500 or 550 deg., as I fully believe he was using 100 per cent excess air.

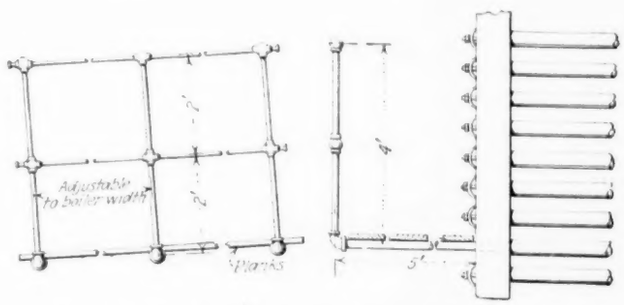
In any installation with coal or oil, reduction of excess air will often cause higher flue-gas temperature, but this cannot be regarded as a preventable loss.

Thompsonville, Conn. G. H. HART.

Tube Turbining Platform for Horizontal Water-Tube Boilers

A PRACTICAL platform to be used on horizontal water-tube boilers while the tubes are being cleaned or turbined is shown in the accompanying sketch. It is easily put in place and easily taken down, and has a safety railing that prevents the workmen from falling or stepping off while at work. This platform can be made from fittings generally found around the plant.

Three pieces of pipe 2½ in. or 3 in. in diameter to fit



Boiler platform made from pipe and railing fittings

inside the tubes and about 9 ft. long; three reducing ells and the pipe and railing fittings constitute the framework. The railing fittings are 1½-in. and the horizontal pipes are 1¼-in. These pipes slip through the 1½-in. fittings with a cap on each end. After the boiler has been emptied, remove three handhole plates in the second row of tubes and pass into the tubes the pipes and fittings as shown, leaving about 5 ft. outside the headers. Then place three or four planks on the pipes and turn the 2½-in. or 3-in. pipes around so the horizontal pipes can be passed through the fittings and the pipe caps put on hand-tight. In removing the stage the only fitting to be taken down is one cap on each horizontal line; all others are kept permanently made up. The platform can be used on boilers of different widths, as there is no changing to be made or fittings removed. W. H. BURTON.

Somerset, Mass.

EXCESSIVE FLUE-GAS TEMPERATURE may be due to soot outside or scale inside of the heating surface, insufficiency of heating surface, forcing the fire, poor circulation of the boiler water, after burning of the furnace gases, and also may result from supplying the furnace with too much excess air.

COMMENTS *from* READERS

Treating Evaporator Feed

In his article, in the Oct. 11 issue, on "Treating Evaporator Feed," Capt. H. C. Dinger presents a proposition that has been similarly contended by me for some time.

It seems clear to me that the advisability of treating the evaporator feed should not be questioned provided, of course, that this is possible with the same degree of success attained in boilers and without introducing the evils referred to by Captain Dinger.

Evaporators are valuable pieces of equipment, demanding considerate treatment if they are to remain in service a maximum length of time. Their function is to convert water to steam—similar to that of the boiler proper, and therefore conditions that are undesirable in boiler operation should in like proportion be undesirable in evaporators.

The prime evil in boiler operation is scale, because its presence reduces the efficiency of the boiler by preventing maximum transfer of heat. The fuel consumed increases with the thickness of scale, and the scale in an evaporator, possessing similar properties, introduces similar objections.

This should answer the question, then, whether the additional trouble and expense involved in removing the scale is worth while. If it is warranted in the case of boiler operation—then it most certainly must be warranted in the case of evaporators.

The attendant evils mentioned by Captain Dinger can be overcome by colloidal conditioning by reason of the fact that, first of all, scale can be prevented without liberating an equivalent amount of soluble salts into the water, and secondly, because colloids, by their characteristic property of adsorption, are capable of removing soluble salts, not only those introduced by treatment, but also those naturally present in the raw feed water.

In dealing with these salts "physically," colloids cannot produce that alkalinity that must inevitably attend the use of soda-base treatments, which rely on chemical reaction for their efficiency and therefore the priming evil need not necessarily be encountered.

New York City. GEORGE C. REINHARD.

* * * *

The Decrease in Students in Mechanical Engineering

IN RESPONSE to James McIntosh's letter in the Sept. 20 issue, may I say that I received my M.E. degree a year ago last June, and I wouldn't change places with a fellow who has spent fifteen years as a machinist, patternmaker or toolmaker. No one will question the statement that experience is necessary, but the assertion that I maintain is wrong is that a man 23 years old who has spent seven years in the shop is better qualified to succeed than his brother of the same age who has just finished college.

The average college graduate isn't expected to, nor does he expect to, guide his shop-trained brother immediately upon starting his first job. Almost every graduate must and does serve a few years' apprenticeship, during which time he gets enough practical experience to qualify him to guide the shop-man. A college graduate does not determine the value of his education by the success he meets with the first two or three years he works, but by the progress he makes in his lifetime.

The textbooks that are used are not obsolete in the sense that they are out of step with present-day practice —they merely contain old facts. These facts have been studied for years and must continue to be studied in order to give the student a good foundation.

The professors that put in year after year teaching these young men are for the most part qualified to hold down responsible positions in the business world. Some of them I have come in contact with do work outside the college that pays them as much as or more than they receive for teaching. One of the best things to teach a man is how to think clearly, and if that is done anywhere, it is done in the engineering college.

I think three things are responsible for the decrease in students in mechanical engineering: Stringent entrance requirements, a difficult course of study and small returns the first few years after graduation. The average college graduate knows that the world will not pay you for what you know, but for what you can do, and I think he is qualified to do more than his shop-trained brother. ALBERT H. KOCH.

Saginaw, Mich.

* * * *

Temporary Engineering Job

COMMENTING on the article by H. Livingstone in the August 2 issue, in which he discusses the advantages of temporary jobs in engineering work, I am inclined to believe that the size of the organization and the extent to which specialization has been carried in the engineering department have considerable bearing on the opportunities for experience and promotion, as the following account of the experience of a mechanical engineer would seem to indicate.

There is also in the larger organization employing a great number of men, the disadvantage that a system of curves or graphs on file in the chief's office, rather than personal contact and observation by the executive, may be the means for determining the desirability of promoting a man or of keeping him on the payroll; and since such curves are generally plotted from information furnished by section heads under whom the man has worked and among whom there may be some whose ability to judge a man's worth may be the least of their qualifications, the value of such graphs is doubtful.

A few years ago a mechanical engineer, having full charge of a department in a manufacturing plant, was obliged to leave on account of a change in the management and seek a position elsewhere. He obtained employment in the drafting room of a large organization employing hundreds of draftsmen, expecting that his previous record would be of advantage in helping him gain promotion.

His first work in the new place was that of machine man in a highly specialized department in the drafting room where there was little drafting or designing to do and less engineering work, the duties consisting principally of making a tentative layout and then writing up lists of parts for a machine, a clerical job which did not particularly appeal to this man, who was an inventor and a specialist on development work. Several months elapsed before he became thoroughly familiar with the complicated system in use in the department, and after being there fourteen months he was transferred to another department.

His next work was entirely different and consisted of standardized welded steel construction. Here he was asked to complete a rush job of detailing, which he finished with credit. Then followed a few minor jobs of designing and detailing, after which he was informed that work was getting slack in the department, and although his services had been satisfactory it would be necessary to transfer him. He had been employed in this section two and one-half months.

He was informed that the superintendent of drafting had a position for him and on reporting to this official was told that a department was being organized and that there was an opportunity there for him. He was received in this new department with anything but cordiality and turned over to the assistant in charge, who gave him an order to design an entirely new machine. This work was more in his line and he got out a good design in record time. He was kept in this department a few weeks longer doing odd jobs and was then told that work was getting slack and that he had better see about a transfer. He had been in this section two months.

He was next transferred to a department where drawings were being copied. This place was evidently a sort of dumping ground, for he recognized several men whom he had previously seen in better positions, but who were here doing copying work and tracing. He stayed in this department nine months doing copying work and making tracings, and at the end of that time was informed by the foreman that his work had been satisfactory and that he was being transferred to a better position.

The first visit to his board of the foreman of the new department brought him the information that his services would be required for awhile. A number of the men in the department also volunteered the information that the boss was a hard man to get along with and that he would be fortunate if he made good with him. He had heard this line of talk before, but being a steady worker he had no doubt of his ability to satisfy the most exacting foreman.

However, this section head turned out to be of the nagging type, intent apparently on cowing a man into abject servility. The new man would look up from his work to find the boss standing behind him and peering over his shoulder at the work that he was doing. After a few words about the progress of the work he would turn and walk up the aisle between the boards only to return by another aisle and startle the draftsman by looking over his shoulder from the opposite side. Should he look up from his table back of him over which he had been bending while doing some figuring, he would often find the foreman peering at him from over the top of the drawing board in front of him. Occasionally, he would stop at the draftsman's table and remark that it was not necessary to do so much thinking on a job, or ask him if he was in need of any information.

Naturally, this sort of thing began to get on the draftsman's nerves and he began to be irritable and inaccurate. This of course was the beginning of the end, and in a few weeks he was told that work was getting slack in the department and that the assistant chief was trying to find a place to which to transfer him. To this he replied "All right," an answer which evidently indicated too much sang froid, for the boss returned to the draftsman's table a few moments later and thumping down his fist informed him that he was being laid off from the section on account of his inaccuracy and loafing. Since the draftsman had kept a record of all drawings that he had turned out while he was in the department and as the time in which they had been completed had been exceptionally good, he did not take the ravings of the boss seriously.

On reporting to the assistant chief he was told that he was considered a good man, but that his work was inaccurate and that the foreman of the copying section had so reported, this being the same foreman, by the way, who had told the draftsman that his work was satisfactory but had neglected to mention any inaccuracy.

However, he was given a position in another department on entirely new work again, the squad boss under whom he worked telling him that he was to be broken in on the work and was to remain in the department. This was decidedly encouraging, and he was careful to note that he made no more errors in his work than other men in his section, although he was not as familiar as they with all the details.

After five months in this department, during which time he completed a few minor jobs and sat idle a great part of the time, he was handed a letter stating that business conditions were such that he had better look for employment elsewhere. As he had just invented a new device for use with the company's machines, a model of which the engineer in charge was having made to try out, and as he had also made improvements in several other devices which he had turned over to the chief, he was somewhat surprised at this action of the company and decided that there must be some mistake but did not immediately look into the matter. A few weeks later, however, he was handed another letter informing him that after a certain date his services would no longer be required.

His inquiries as to the reason for his discharge brought only the reply that business conditions warranted it and that he had done nothing to justify the action.

Being a married man with a family, he was at a loss to account for such a summary dismissal. Although he had been in several departments, the work was so highly specialized and he had been in them such a short time that the experience he had gained was too limited to be of much value to him. On the whole he considered the

three years spent in the large organization almost a total loss.

Previous to entering the employ of this firm he had been promoted from designer to engineer, to engineer in full charge of a department, with his former employer. Under another employer he had held the positions of draftsman, squad leader and inspector in the drafting room; and inspector, chief inspector and foreman in the machine shop.

He is inclined to believe that he was the victim of the old Indian custom of running the gauntlet. Here, if you recall, the Indians lined up in two rows between which the prisoner was compelled to run and dodge if he could the blows which the Indians aimed at him with clubs as he passed by them. If he escaped death, he was adopted into the tribe, but if he happened to be killed, at least everyone had had a good time and no one was the loser except the tribe which had lost a more or less valuable member.

O. B. SERVER.

Schenectady, N. Y.

* * * *

Present Industrial Conditions an Opportunity for the Plant Engineer

THAT the present industrial situation generally is featured by conditions puzzling to economists is admitted by some of the most prominent industrial bankers and business statisticians. We have a plethora of credit, ordinarily a stimulus to inflation, and we do an enormous and growing volume of business, which is characteristic of inflation.

Yet commodity prices have for some time steadily fallen, which is by no means an indication of inflation. Quite the contrary, in fact.

The most able business students explain the situation by declaring that we have no real inflation as yet, but that cheap money has been, and still is, stimulating the expansion of plant capacity; and that the huge volume of business being done at falling prices is the result of a general effort to keep our large production capacity gainfully employed.

Therefore, despite the growing volume of business being done, there are many complaints of poor business among the average business men. The country as a whole has been producing on a huge scale, but a great many organizations are not making any money. In the effort to keep plant capacity busy enough to carry their overhead, their operating margin has been narrowed to a point where, in many cases, profits have entirely vanished. Most of the money earned is being made by the largest organizations by virtue of their enormous mechanical development. In this situation the best opportunity of the industrial plant lies in turning toward sources of economy commonly ignored or forgotten. Under such conditions savings made in power cost may mean the salvation of many a plant. With the great volume of business being done at the present time, the average person is probably not aware that current business failures have swelled to a startling figure.

The crux of this discourse is the fact that present industrial conditions offer a big opportunity for the average industrial power plant engineer to make a hit with the management by showing how a percentage of the production costs can be transferred from the debit to the profit side of the ledger, a proceeding that in many cases would mean the difference between a net profit and a net loss—the difference, perhaps, between beating competition and being beaten by it.

About a year ago I saw a table showing the relation between power costs and production costs in each of 100 industries. Power costs in the industries listed comprised from ½ of 1 per cent to 29 per cent of total production costs, the average being about 8 per cent.

A survey of industrial power plants showed the average boiler and furnace efficiency to be about 56 per cent. An authority has stated that in the present state of the art the average plant, if properly equipped and operated, should develop an efficiency of not less than 80 per cent.

Of this improvement, amounting to 25 per cent, at least one-half could be effected by no more elaborate means than the installation and intelligent use of modern power plant instruments, essential to economical power plant operation.

One-half of 25 per cent is 12½ per cent. Therefore, if in the average industrial power plant, operating costs represent 8 per cent of the total production costs, and of this 8 per cent we save 12½ per cent or one-eighth, the result is that production costs of the whole plant are reduced 1 per cent. If we assume that the net profit of a given concern has been reduced to 5 per cent, the saving of 1 per cent is equal to a 20 per cent increase in net profit.

Or if, as is undoubtedly the case with a good many businesses right now, we assume that a given concern is making no profit at all, then this 1 per cent saving may mean the difference between loss and profit; or, as stated in the outset of this article, it may mean the difference between beating competition and being beaten by it.

These are facts, and it appears that now is the time for the power-plant engineer who is operating a plant at low economy because of the lack of proper instruments, to run his boilers in a really intelligent way, to go to the front and impress on the general manager or president what savings could be effected by the installation of proper power plant instruments.

For instance, the better balancing of loads among a number of boiler units, resulting from the use of flow meters has been shown by experience in many plants to produce an average fuel saving approximating 5 per cent.

Unless flue-gas temperature at the stack is systematically observed, the operator is blind to the condition of his boiler. High flue-gas temperature means dirty tubes and wasted heat. To be specific, flue-gas temperature 100 deg. too high represents a loss of about 4 per cent of the fuel burned.

At the same time the use of these instruments usually effects substantial savings in labor and maintenance costs. Not only operating costs, but fixed charges are held to a minimum by proper power-plant instrument equipment. The introduction of flow meters, for instance, frequently enables the plant engineer to load his boilers to such advantage that purchase of an additional unit that had been planned for becomes unnecessary, its price being retained in the working capital of the concern instead of being tied up in a unit not actually needed.

Every executive of an industrial organization is interested in profits. The industrial power plant engineer can enhance appreciation of his value in the estimation of his employers easily and forcibly by driving home the relation between power plant costs and profits.

Philadelphia, Penn. RICHARD P. BROWN.

NEWS *of the* FIELD

Failure of Flywheel Demolishes Plant of Lehigh Portland Cement Co.

Corliss Engine and Building Wrecked by Accident of Unknown Origin —Heavy Damage But No Employees Injured

AT PLANT No. 2 of the Lehigh Portland Cement Company at Mitchell, near Bedford, Ind., failure of a flywheel early in the morning of Nov. 18 wrought much damage to the plant in addition to completely demolishing the 125-hp. Corliss engine. All of the employees on duty escaped injury. The engine room was badly wrecked. The plant's main steam line was broken, allowing steam to escape from all boilers and electric lines were also severed, shutting off all lighting systems and electrical machines in use throughout the company's various plants, including their mills, quarries and lime kilns, the latter two plants being several miles distant from the point of the accident.

The flywheel which broke was 12 ft. in diameter and had an 18-in. face. The belt was totally destroyed.

This engine was of the usual single eccentric Corliss type with a pendulum governor driven by belt from the crankshaft. It was equipped with an overspeed stop device of a make which was not ascertained at examination after the accident. Apparently having seen several years' service, the engine, in good condition as far as could be learned, was 16 x 48 in., 88 r.p.m., 150 lb. steam pressure, with an open type left-hand crank. It was belted to a line shaft which drove a load of heavy grinders.

The switchboard being on the opposite side of the engine room the men were there at the time, and so escaped with no injuries. The belt centers were approximately 20 ft.; the driven pulley was mounted on a concrete base.

It is not known just how or what caused this smash-up. The engine crank was broken off about midway between shaft and crankpin, the piston rod nut stripped off, and the connecting rod crosshead and piston rod thrown clear of the engine. The flywheel, which was also the drive pulley, demolished part of it, going through the roof. Pieces wrecked the valve gear on a cross-compound 800-hp. Corliss set head end to head end and with about 40 ft., between engines, tore off the throttle valve and 8-in. steam line, also broke a 12-in. exhaust line. A 6-ft. belt on the cross-compound engine was chewed up considerably by flying pieces falling.

Steam filled the engine room and it was impossible to go in till the pressure had subsided. Some electric feeder lines were severed, but an efficient crew in a few hours had operation back to normal again and a motor driving the wrecked engine's load.

West Texas Utilities Plans Power Supply

Power for the 400-mile pipe line from the Yates oil field in Pecos County to tidewater at Houston will be supplied by the San Angelo plant of the West Texas Utilities Company, it is announced by G. L. Murphy, assistant superintendent of the San Angelo district of the utilities company. The San Angelo plant is now being enlarged to 16,000 hp. to take care of this extra load.

One of the largest utility undertakings of the year is now under way, with the West Texas Utilities and the Central Power & Light Company, sister organizations, effecting an interconnection to furnish the power. Before the power companies can begin operations there must be completed at least the first unit of a hydro-electric power plant on Devil's River, sixteen miles northwest of Del Rio. This initial generation of power means at least 2,500 hp. extra force will be added to the capacity already added at Del Rio. It is to be augmented within a month by installation of a 1,150-hp. De Lavergne engine with an 800-kw. generator.

Buys Kansas Utility Properties

Control and ownership of the Union Gas Corporation, Kansas, which supplies 22 Kansas and Oklahoma towns, passed recently from the hands of local men to the Commonwealth Power Corporation, of New York. The consideration was said to be nearly $2,000,000.

The company had oil and gas production in five Kansas counties and in two in Oklahoma.

The cities supplied are Altoona, Benedict, Burlington, Caney, Coffeyville, Buffalo, Fredonia, Independence, Liberty, Lafountaine, Olathe, Spring Hill, Syracuse, Yates Center, Chanute, Moline, Elk City, Longton, Tyro and Havana, all in Kansas, and Sperry and Skiatook, Oklahoma.

Policy on Merchant Marine Urged on Government

The imperative necessity for the formulation by the federal government of a definite policy relative to the American merchant marine was voiced at the White House on Nov. 16 by Representative William R. Wood, Republican, of Indiana, and a member of the House Appropriations Committee. He did not, however, discuss the subject with President Coolidge.

Representative Wood stated orally after conferring with the President that 99 out of every 100 with whom he had discussed the subject favored private, rather than government, ownership of the merchant marine.

There ought to be, he said, a disposition of the question at the earliest possible moment in order to protect American shipping interests. "Our ships," Mr. Woods said, "are becoming obsolete, are retrograding and are not as speedy as are the ships of other nations."

Representative Wood said he believed that there was considerable virtue in the plan proposed by Edward N. Hurley, former Chairman of the United States Shipping Board, which called for operation of shipping lines by the railroads and for a large revolving fund to be loaned to private interests at a low interest rate for the encouragement of American ship construction.

Further Dieselization Probable

Governor Ralph O. Brewster, of Maine, conferred with President Coolidge at the White House, November 21, and later, in an oral statement, declared that a direct subsidy of $25,000,000 annually must be paid to private ship owners if the American merchant marine is to be continued on the high seas.

"By a direct subsidy of $25,000,000 a year we would be certain that at least half of our foreign trade would be carried in American merchant vessels."

Governor Brewster said that the subsidy should be based upon the size and condition of the ships, the length of their trade routes and difference in cost in the United States and the countries to which they ply. Governor Brewster said that President Coolidge appeared to be sympathetic to his proposition.

Further impetus to the appreciably gaining movement toward marine Dieselization would most probably result from such a marked increase of our merchant marine.

Installs 4,000 Kw. Automatic Converter Unit

A 4,000-kw. 600-volt converter which is to be installed alongside another unit of the same kind by the New York Rapid Transit Company has recently been built. Both units were furnished by the Westinghouse Electric & Manufacturing Company.

The new machine is a 4,000-kw. 575-volt direct-current shunt-wound converter and is supplied from a three-phase 4,200-kva. 11,000-volt 25-cycle power transformer. The high-tension connections of the transformers are connected in star for starting and in delta for full secondary voltage when the running breaker is closed.

An interesting feature of the equipment is the method of operation by means of supervisory control. To start up the machine, the operator at the adjacent New Utrecht station operates a small telephone key which initiates the operation of the automatic supervisory relay equipment, resulting in closing of a relay at the substation to start the machine. The machine then automatically starts and connects itself to the alternating-current and direct-current systems without an attendant.

Regulates Other Operations

In addition to starting up the machine, supervisory control will regulate other operations such as shutting down the machine, operating the thirteen feeder breakers, closing or opening the high-tension breakers, and closing or opening any of the six track breakers. The dispatcher has at all times an indication of the position of all the breakers listed above, of the position of the main direct-current breakers, and even of the opening of the substation door.

By a unique method of remote metering the total current furnished by the unit may be read continuously, and by a selective method, the current in any one of the individual feeder circuits can also be read by the dispatcher.

Turbine-Generator, 60,000 Kw., for Birmingham, Ala.

The first single-cylinder turbine-generator, to be rated at 60,000 kw. for service south of the Mason and Dixon Line will be the initial installation in a new station being built by the Dixie Construction Company near the site of the present Gorgas station of the Alabama Power Company near Birmingham.

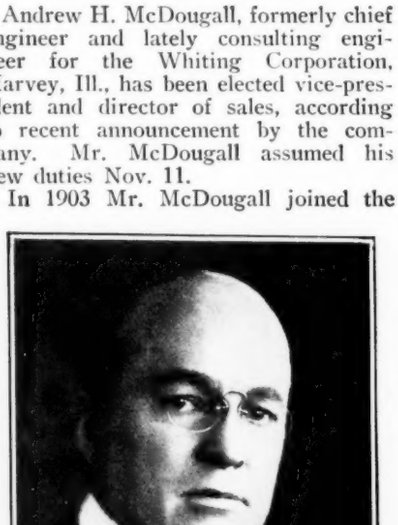
The ultimate capacity of the station will be 240,000 kw., and will be used to meet the fast growing load demand of the south. The new unit is now being manufactured in the Schenectady shops of the General Electric Company.

The turbine will operate at a steam pressure of 400 lb. gage, at a temperature of 725 deg. F., and will exhaust against an absolute back pressure of 2 in. of mercury. The generator will be of the totally inclosed, externally ventilated type, delivering 66,667 kva. of energy at 13,800 volts, 60 cycles, three-phase, and 90 per cent power factor.

Elects Andrew H. McDougall as Vice-President

Andrew H. McDougall, formerly chief engineer and lately consulting engineer for the Whiting Corporation, Harvey, Ill., has been elected vice-president and director of sales, according to recent announcement by the company. Mr. McDougall assumed his new duties Nov. 11.

In 1903 Mr. McDougall joined the



Andrew H. McDougall

Whiting Foundry Equipment Company (now the Whiting Corporation), manufacturers of cranes, foundry equipment and railway specialties, as designer. Successively, since that date, he has served as estimator, chief draftsman, chief engineer and vice-president and consulting engineer.

Graduated from Michigan University with the degree of mechanical engineering in 1901, Mr. McDougall worked as a machinist with the E. D. Smith Company on the Michigan-Lake Superior Power Canal project, Sault Ste. Marie, Ontario, and later similarly with the Allis-Chalmers Manufacturing Company, Milwaukee.

Mr. McDougall is a member of the American Society of Mechanical Engineers, American Society of Civil Engineers, and the University Club of Chicago.

To Convene in London

The Institution of Civil Engineers of Great Britain will celebrate the centenary of its organization in June of next year, concurrent with an engineering conference to be held at London.

Refrigeration in Queens, N. Y. Topic at A.S.R.E. Meeting

Growth of electric power for refrigeration, particularly in regard to that used in the Borough of Queens, N. Y., was the general topic of the November meeting of the New York Section of the American Society of Refrigerating Engineers, held Nov. 16 at the Queens Chamber of Commerce of Queens Borough.

Present at this meeting were 85 members and guests. The entire section was invited as guests of the New York and Queens Electric Light & Power Company.

President Bennis introduced H. L. Snyder, vice-president of the New York & Queens Electric Light & Power Company, who welcomed the members, and related in an interesting paper the growth of the Borough of Queens and also that of his company during the last fifteen years.

Stresses Dealers' Importance

Following Mr. Snyder, C. A. Barton, general commercial manager of the New York & Queens gave some figures concerning the growth of electric power for refrigeration in Queens. Mr. Barton then went into detail regarding the future of the small domestic machine and the enormous part of this field that has not been taken care of as yet. He laid particular stress on the importance of the smaller dealers such as the delicatessen and small butcher shops that are large potential customers of these small refrigerating equipments and he believes that in the next decade there will be seen remarkable growth in this field.

Following Mr. Barton, John Adams and C. H. Schaefer, executives of the Breyer Ice Cream Company were introduced, who gave some idea of their new plant at Long Island City. Then the party adjourned to the plant where it had an opportunity of making a personal inspection.

Shoals Power Interest Waxes Nitrate Question Aside

Members of Congress, assembling in Washington for the new session, are taking a much more hopeful view of the prospects for disposing of Muscle Shoals. This is the first indication of any development likely to break the impasse into which this legislation has headed previously.

While there can be no question that sentiment among farmers strongly favored large-scale fertilizer manufacture at Muscle Shoals, it has become generally understood that it would be impossible to put through such a plan and there has been also the realization that the development of the art of nitrogen fixation has made great progress since the Ford offer was made.

For these reasons the testimony of the Secretary of Agriculture before

the Military Affairs Committee just prior to the close of the last session of Congress has had great weight. At that time Secretary Jardine suggested a separation of power development from the operation of the nitrate plants. The fact that he is convinced the existing facilities at Muscle Shoals for the manufacture of fertilizer could not compete with modern plants has influenced many of the farm leaders to accept his suggestion that the power be sold to the highest bidder and the proceeds used in efforts to improve the fertilizer situation.

Exploding Boilers Kill Five—Injure Four

Two boiler explosions occurred recently, one at Troy, Ala., and one at Shreveport, La., taking a total of five lives, four men seriously injured and heavy loss of property.

At Shreveport the blast occurred on an oil drilling rig of the Woodley & Collins Company Nov. 13, killing two men and seriously burning three others. The explosion, thought to have been caused by low water, blew the boiler about 80 feet distant, blasting away the crown sheet.

At Troy the boiler explosion occurred Nov. 1 at the Dyers Sawmill, causing three deaths and the scalding of another man. The mill was blown to bits, and the bodies of the men hurled more than 100 feet.

Exact details of the accident could not be learned, but those familiar with the operation of the steam plant believed the water was allowed to fall low enough in the boilers to permit the crown sheets to become redhot. When the injectors were turned on, the water striking the overheated boiler plates generated steam faster than the safety valve could pass it off and the explosion resulted.

Power will report when further details as to the cause of these explosions are available.

Calls Conference on Speeds of Driven Machines

A general conference will be held in the board room of the American Engineering Standards Committee, 29 West 39th St., New York City, at 10 o'clock, Dec. 9, to determine whether there shall be set up a national system of standard speeds for driven machinery.

This conference is called in connection with a request received by the American Engineering Standards Committee from the National Electrical Manufacturers Association.

Under present conditions the speeds of driven machinery form practically a random distribution without any logical ordering of the values used. As a result of this, the sizes of pulleys, gears, sprockets, etc., which manufacturers have to produce, have been multiplied almost endlessly.

The American Engineering Standards Committee has authorized the calling of a general conference of those industries concerned in this matter to discuss the problem in a preliminary way, to decide upon the desirability of the standardization and, if it is considered desirable, to outline the scope and method of organization of the work.

Alonzo G. Kinyon, Fuel Expert and Inventor, Dies

Alonzo Gaylord Kinyon, consulting engineer with the Fuller Lehigh Company, Fullerton, Pa., well-known for many valuable contributions in a wide variety of subjects, especially for his invention and development of the Fuller-Kinyon conveying system for transporting pulverized material, died Nov. 13, following an operation at Johns Hopkins Hospital, Baltimore.

Born at Amboy, Ill., July 12, 1867, Mr. Kinyon early became associated with railroad work in various stages. From 1882 to 1892 he served as locomotive fireman on the Chicago, Milwaukee & St. Paul R.R., and as locomotive engineer to 1900. For the next six years, while airbrake and locomotive operation instructor with the International Correspondence Schools, Mr. Kinyon became active with the development of fuel burning equipment and fuel conservation in the interest of several railroads. Among his achievements in this line was the solving of the black smoke problem for the New York, New Haven & Hartford R.R., particularly in the Park Avenue Tunnel, New York City, in 1905. Following work on a rotary steam engine, he served as traveling engineer for the South Railway, Columbia, S. C., in 1909 as special instructor of fuel economy for the Buffalo, Rochester & Pittsburgh R.R., and in similar investigation work for the Manastee & N.E. Railway.

Recipient of Longstreth Medal for Many Achievements

In 1916 Mr. Kinyon joined the Powdered Coal Engineering & Equipment Company, Chicago, but the year after resigned to organize the Kinyon Pulverized Fuel Engineering Company to put on the market self-contained pulverized fuel burning units for hotel and apartment buildings. This concern was taken over by the Fuller Lehigh Company in 1918, and Mr. Kinyon became associated with that company with which he continued as manager of the conveying department until his death.

While his service to industry was marked by numerous contributions, the outstanding point in Mr. Kinyon's career was the Fuller-Kinyon conveying system for transporting pulverized material, now widely in use in many diversified industries. In recognition of his efforts he was on Nov. 11, 1926, awarded the Longstreth Medal by the Franklin Institute as well as life membership in that organization.

Illinois Society Meets for Annual, January 4

Directors of the Illinois Society of Engineers meeting in Urbana, Ill., recently announced Jan. 4-6 as dates for the annual meeting of the organization, which will be held at the University of Illinois.

University faculty members who are serving on the board of directors are: Dr. M. M. Leighton, Profs. H. E. Babbitt, W. J. Putnam and A. M. Buswell and G. C. Habermeyer; and other directors are: W. J. Schafmeyer and J. A. Moore, Chicago; J. J. Woltmann and M. C. Taylor, Bloomington, and D. P. Warren, Decatur.

Boiler Companies Merge

Merger of the Newport Boiler Company with the Hart-Parr Company, of Charles City, Iowa, was ratified last week at a meeting of stockholders of the Newport concern. Cast-iron boilers for the Newport company have been produced by the Hart-Parr Company since 1921, and it is proposed to maintain a Newport boiler division in Chicago similar to the branches maintained at other points.

Obituary

Edward Hubbard Wells, chairman of the board of Babcock & Wilcox Company, New York City, died Nov. 12 after an illness of several months. Mr. Wells, who was in his 69th year, was born in Dorrville, R. I. and had lived in Montclair, N. J., for the last twenty-five years. He started with the Babcock & Wilcox firm in 1892 as engineer in charge of sales. In 1898 he became president of the company, holding that position until eight years ago, when he assumed the position he held at the time of his death.

Personal Mention

C. V. Bullen has joined the department of electrical engineering of the University of Oklahoma.

J. M. Flanigen, electrical engineer, has resigned his position with the Ohio Public Service Company, Alliance, Ohio, to become associated with the Georgia Power Company at Rome, Ga., Dec. 1.

Joshua E. Hannum, recently engaged in directing the safety and production study of the American Engineering Council, has been appointed editor of the Engineering Index Service conducted by the A.S.M.E.

George W. Wilmarth has been appointed chief operating engineer for the Northern States Power Company, according to announcement by R. F. Pack,

vice-president and general manager. Mr. Wilmarth will have his office in Minneapolis.

DR. W. D. COOLIDGE, assistant director of the research laboratory of the General Electric Company, has been awarded the Hughes Medal by the Royal Society for "distinguished work on the X-rays and the development of highly efficient apparatus for their production."

S. ROSENZWEIG, vice-president and consulting engineer of the Korfund Company, will leave for Europe in December to study the latest developments in the isolation of machinery against the transmission of vibration and noise. Mr. Rosenzweig is an active member of the A.S.M.E.

HAROLD L. GEISSE will assume his duties as manager of the Wisconsin division of the Northern States, with offices in Eau Claire, in addition to those of general manager of the Wisconsin Valley Electric Company and affiliated companies, with headquarters in Wausau, which position he has occupied since 1921.

W. H. SAWYER, who has for 8 years been president of the East St. Louis & Suburban Railway Company of East St. Louis, Illinois, has resigned to become president of Stevens & Wood, Inc., of New York. In his new position, Mr. Sawyer will be in charge of the operation of public utilities in eight states, among which are the American Electric Power Co. and the Penn-Ohio System.

GLENVILLE ARTHUR COLLINS, consulting engineer, announces the opening of offices at 704-5 Hollingsworth Building, Los Angeles, for rendering service in the mechanical and mining branches of engineering. For the past four years Mr. Collins was manager of the power division of the Southwestern Engineering Corporation of Los Angeles, in which capacity he designed and patented the Collins water tube boiler. In consulting he now offers his services in all phases of power work, material handling and industrial manufacturing problems.

Society Affairs

A.S.M.E., ST. LOUIS, Dec. 2, Hotel Roosevelt, at 6:30 p.m.; dinner for past chairman of the St. Louis local section.

A.S.M.E., GREEN MOUNTAIN, Dec. 1, Springfield, Vt., at 7:15 p.m.; talk on compressed air and its uses by F. D. Holdsworth, engineer, Sullivan Machinery Company.

A.S.M.E. and WESTERN SOCIETY OF ENGINEERS will hold a joint meeting Dec. 19, 1936 Monadnock Block, Chicago, — subject, "Energy from the Atom."

A.S.M.E., BUFFALO, Dec. 13, Hotel Statler, at 8:00 p.m.; "The Present Standing of Various Standards Now Being Developed for Valves and Fittings for High Pressure Steam Service," by F. H. Morhead, chief engineer of the Walworth Company. There will also be slides showing in detail the design of high pressure valves and fittings for application to service requirements.

AMERICAN REFRACTORIES INSTITUTE will hold meetings at the Hotel Chase, St. Louis, Mo., Dec. 6-7. Papers of interest will include "Dry Grinding of Refractories," by Mr. J. M. Gallaher, works manager, Clearfield Machine Company, Clearfield, Pa., and "Burning Refractories with Stokers," by Massillon Refractories Company, Massillon, Ohio. Inquiries concerning sessions should be directed to the secretary of the American Refractories Institute, 2202 Oliver Building, Pittsburgh.

AMERICAN INSTITUTE of Weights and Measures, 115 Broadway, New York City, will hold its annual meeting at

Coming Conventions

American Boiler Manufacturers Association, winter meeting, Hotel Cleveland, Cleveland, Feb. 7; A. C. Baker, sec., 801 Rockefeller Bldg.

American Engineering Council, annual meeting will be held in Washington, D. C., Jan. 9-11; L. W. Wallace, executive secretary, 26 Jackson Place, N. W., Washington, D. C.

American Institute of Electrical Engineers, Great Lakes District regional meeting at the Hotel Drake, Chicago, Nov. 28-30, Address J. E. Kearns, chairman registration committee, General Electric Company, 230 South Clark St., Chicago.

American Society of Heating & Ventilating Engineers, hold general meeting at Hotel Pennsylvania in New York City, Jan. 23-26; A. V. Hutchinson, sec., 29 W. 39th St., New York.

American Society of Refrigerating Engineers, annual convention in New York, Dec. 5-7; W. H. Ross, sec., 37 W. 39th St., New York City.

American Water Works Association. Annual meeting, Hotel Fairmont, San Francisco, June 11-16; W. M. Niesley, 170 Broadway, New York City.

American Society of Mechanical Engineers, convention during week of New York Power Show, New York City, Dec. 5-10; Calvin Rice, sec., 29 West 39th St., New York City.

Midwest Power Conference and Exhibition, at Chicago, Feb. 14-17; G. E. Pfisterer, sec., 53 West Jackson Blvd., Chicago.

National Association of Practical Refrigerating Engineers. Eighteenth annual convention and educational exhibition in Civic Convention Hall and headquarters Hotel Whitcomb, San Francisco, Calif., Nov. 29 to Dec. 2. H. Fox, 5707 W. Lake St., Chicago, Ill.

National District Heating Association, annual meeting in May; D. L. Gaskill, sec. 112 West 4th St., Greenville, Ohio.

New York Power Show (National Exposition of Power and Mechanical Engineering) will be held at the Grand Central Palace, New York City, Dec. 5-10. Address inquiries to the International Exposition Co., Grand Central Palace.

The National Marine Engineers' Beneficial Association, 53rd annual convention, will meet at the Lee House, 15th and L Streets, N. W., Washington, D. C., February 13-18. Albert L. Jones, Secretary-Treasurer, 313 Machinists Building, Washington, D. C.

Power Transmission Association. Annual meeting, Hotel Commodore, New York City, Dec. 7; W. S. Hays, Sec., Drexel Building, Philadelphia.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	Market Quoting	Nov. 16 1927
Pool 1	New York	$2.35@$2.75
Smokeless	Boston	1.39
Clearfield	Boston	1.60@ 1.85
Somerset	Boston	1.70@ 2.10
Kanawha	Columbus	1.40@ 1.60
Hocking	Columbus	1.50@ 1.75
Pittsburgh	Pittsburgh	1.75@ 1.90
Pittsburgh gas slack	Pittsburgh	1.10@ 1.25
Franklin, Ill.	Chicago	2.25@ 2.50
Central, Ill.	Chicago	2.00@ 2.25
Ind. 4th Vein	Chicago	2.00@ 2.35
West Ky.	Louisville	1.00@ 1.50
S. E. Ky.	Louisville	1.25@ 1.75
Big Seam	Birmingham	1.65@ 2.00
Anthracite (Gross Tons)		
Buckwheat No. 1.	New York	2.75@ 3.25
Buckwheat No. 1.	Philadelphia	3.00@ 3.75
Birdseye	New York	1.40@ 1.65

FUEL OIL

New York—Nov. 23, light oil, tank-car lots, 26 deg. Baumé, 5c. per gal.; 28 deg., 5½c. per gal., f.o.b. Bayonne, N. J.

St. Louis—Nov. 15, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.55 per bbl.; 26@28 deg., $1.60 per bbl.; 28@30 deg., $1.65 per bbl.; 30@32 deg., $1.70 per bbl.; 32@36 deg., gas oil, 4.3c. per gal.; 38@40 deg., 5¼c. per gal.

Pittsburgh—Nov. 15, f.o.b. local refinery, 30@34 deg., fuel oil, 4½c. per gal.; 36@40 deg., 4⅝c. per gal.

Philadelphia—Nov. 16, 26@30 deg., $1.60@$1.66 per bbl.; 13@19 deg., $1.56 @$1.62 per bbl.; 22 plus, $1.79@$1.85 per bbl.; 27@30, $2.10@$2.16 per bbl.

Cincinnati — Nov. 15, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 4.9c. per gal.; 26@30 deg., 5.15c. per gal.; 30@32 deg., 5½c. per gal.

Chicago—Nov. 19, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl.; 22@26 deg., 80@85c. per bbl.; 26@30 deg., 90c. per bbl.; 30@32 deg., $1.05 per bbl.

Boston—Nov. 21, tank-car lots, f.o.b., 12@14 deg. Baumé, 4.22c. per gal.; 28@ 32 deg., 5⅜c. per gal.

Dallas—Nov. 19, f.o.b. local refinery, 26@30 deg., $1.45 per bbl.

2.30, Dec. 8. Following administration business plans will be discussed for the recommendation of names for the thousandth of an inch, a small American unit of volume of the order of magnitude of the cubic centimeter, and a unit of weight to replace the gram.

THE ENGINEERS CLUB OF PHILADELPHIA will celebrate the fiftieth anniversary of organization at the Bellevue-Stratford, Dec. 16-17, with the general subject "Engineering Progress and World Civilization" treated in a series of addresses by John R. Freeman, Ambrose Swasey, William C. L. Elgin, Howard Elliott, Charles M. Schwab, Samuel Rea, Dexter S. Kimball and John Hays Hammond. Non-members of the club desiring to be present during any portion of the program should communicate with Charles E. Billin, secretary, 1317 Spruce Street, before Dec. 12.

Business Notes

THE LINCOLN ELECTRIC COMPANY, Cleveland, announces the appointment of R. M. Plympton as salesman in charge of consumer motor business in Chicago. Mr. Plympton will work under the direction of R. D. Malm, Chicago district manager.

THE BAILEY METER COMPANY announces the removal of its main office and works from 2015 East 46th Street to the new plant at 1050 Ivanhoe Road, Cleveland.

Trade Catalogs

STACK METERS—Charles Engelhard, Chestnut St. and N. J. R.R. Ave., Newark, N. J., describes in Bulletin 262 the Engelhard electrically operated stackmeter for recording the CO_2 and stack temperatures continuously on a chart. The chart used is $6\frac{1}{8}$ in. wide and graduated 0-20 CO_2 and from 100 to 1,100 deg. F. The full width of the chart is used for each record. Price lists and specifications of these recorders are included.

VALVES—The Homestead Valve Manufacturing Company, Homestead, Pa., has issued Catalog No. 34, the latest showing the Homestead line is now available for all users of valves, in power plants, process or general industries. Listed and described, for the first time in this illustrated catalog is the Homestead protected seat hydraulic operating valve with remote control attachment. Also larger size Homestead quarter-turn plug valves equipped with gear operating device, and the Homestead Ross air valve. This reference book will be sent on request to any valve user who is interested.

AUTOMATIC REGULATING SPECIALTIES—The Fisher Governor Company, Marshalltown, Iowa, is presenting to the trade a new bulletin catalog consisting of a paper cover binder, in which are assembled bulletins describing many of the different automatic regulating specialties of the company. These include governors and regulating devices for pumps, reducing valves and pressure regulating devices, gas-pressure regulators or reducing valves, strainers, tank and liquid-level controllers, vacuum regulators, cyclonic and jet mixers and miscellaneous power plant and steam specialties. As new bulletins are issued, they may be placed in this binder, which forms a convenient file.

NEW PLANT CONSTRUCTION

Calif., Los Angeles—Los Angeles County had plans prepared for the construction of a hospital, including power house, at Olive View Sanitarium. E. Bergstrom, Citizens National Bank Bldg., M. Hunt, Hibernian Bldg. and P. Davis, 3215 West 6th St., are architects.

Calif., Los Angeles—Mack Sennett Co., Hollywood, awarded contract for a group of studio buildings including power plant, etc., at Ventura Blvd. and Laurel Canyon Rd., E. to The Austin Co., 777 East Washington St.

Calif., Los Angeles—Marchants Ice & Cold Storage Co., 518 Seaton St., is having plans prepared for the construction of an ice plant. Estimated cost $100,000. Llewellyn A. Parker, 1105 Kerckhoff Bldg., is architect.

Calif., Los Angeles — J. H. Miller, 317 Douglas Bldg., is preparing preliminary sketches for a 13 story hotel and theatre building at North Western Dist., also two 5 story apartment buildings at Country Club Dr. and Norton Ave. Estimated cost $1,000,000 and $825,000 respectively. Owner is general contractor.

Calif., San Francisco—Marian Realty Co., 110 Sutter St., is having plans prepared for an 8 story apartment building at Pacific Ave. and Laguna St. Estimated cost $600,000. D. D. Stone, 354 Hobart St., Oakland, is architect.

Calif., San Ysidro—Tia Juana Irrigation Dist., is having plans prepared for waterworks improvements including reservoir, pumping plant, etc. Estimated cost $250,000. J. H. Chase, Jackson Bldg., Riverside, is architect.

Del., Bethany Beach—U. S. Property & Disbursing Officer, Washington, D. C., will receive bids until Nov. 30 for the construction of group of buildings including power house, etc., here.

D. C., Washington—Constructing Quartermaster, will receive bids until Dec. 1 for the construction of boiler houses in Hangars 1, 2, 3, 4, 5, 6 and 10 at Bolling Field.

Illinois-Missouri-Oklahoma-Texas—Ozark Pipe Line Corp., Shell Bldg., St. Louis, Mo., plans the construction of a pipe line from Chicago, Ill. to Cushing, Okla., also from Cushing to Healdton, Okla. and from Healdton through North and Central West Texas to Pecos fields; pumping stations will be located about every 100 miles. Private plans.

Ill., Chicago — Agricultural Club of America, c/o W. H. Pruyn, 122 South Michigan Ave., Archt., is having sketches made for a 21 story agricultural building near municipal pier. Estimated cost $35,000,000.

Ill., Chicago—Syndicate, c/o M. L. Bein, 64 West Randolph St., Archt., is receiving bids for an 8 story apartment building at 1117-1123 North Dearborn St. Estimated cost $1,000,000.

Ill., Chicago — Y. M. C. A. Assn., 19 South La Salle St., awarded contract for the construction of a 5 story Y. M. C. A. building at 3533 North Marshfield Ave., to R. C. Weiboldt Co., 1534 West Van Buren St. Estimated cost $750,000.

Ind., Evansville—City is having plans prepared for waterworks improvements including 20,000 gal. reservoir, pumping station, pumping equipment etc. Estimated cost $1,195,000. Black & Veatch, 700 Mutual Bldg., Kansas City, Mo., are engineers.

Ia., Marshalltown — Eppley Hotels Co., E. C. Eppley, Pres., Hotel Fontenel, Omaha, Neb., awarded contract for an 8 story hotel here to H. L. Stevens & Co., 30 North Michigan Ave., Chicago, Ill. Estimated cost $500,000. Vacuum heating system, etc., will be installed.

Mass., Boston—Atlantic Building Trust., c/o M. C. Burton, 470 Atlantic Ave., is having plans prepared for a 13 story office and commercial building including power plant at Atlantic Ave. and Pearl St. Extension. Estimated cost $4,000,000. Blackall, Clapp & Whittemore, 31 West St., Boston, are architects.

Mass., Boston—Boston & Maine R.R., is having sketches made for a 14 story hotel and office building, etc. on Causeway St. Estimated cost $3,000,000. Funk & Wilcox, 26 Pemberton Sq., are architects. Fellheimer & Wagner, 155 East 42nd St., New York, N. Y., are consulting architects. W. J. Backes is chief engineer.

Mass., Dorchester (Boston P.O.)—Transit Dept., 1 Beacon St., Boston, awarded contract for the construction of a power sub-station on Beale St. here to White Construction Co., 11 Beacon St., Boston. Estimated cost $50,000. Also soon lets contract for a heating plant.

Mass., Everett (Boston P.O.)—Malden Electric Co., 139 Pleasant St., Malden, awarded contract for the construction of an electric sub-station on Thorndike St. here to Coleman Bros. Co., 245 State St., Boston. Estimated cost $50,000.

Mass., Roxbury (Boston P.O.)—Edison Electric Illuminating Co., 39 Boylston St., Boston, awarded contract for the construction of an electric sub-station, No. 143 here, to J. A. Fitzgerald Construction Co., 38 Chauncy St., Boston. Estimated cost $100,000.

Mass., South Lawrence (mail Lawrence)—B. L. McDonald Co., 398 Essex St., Lawrence, is receiving bids for the construction of an artificial ice plant on Andover St., here. Estimated cost, $40,000. Funk & Wilcox, 26 Pemberton Sq., Boston, are architects.

Mich., Detroit—Chrysler Corp., 341 Massachusetts Ave., is having plans prepared for the construction of an enameling plant for automobile factory, including detached power plant on East Jefferson Ave. Smith, Hinchman & Grylls, 800 Marquette Bldg., are architects.

Miss., Moss Point—Southern Paper Co., awarded contract for boiler house changes including conversion of oil burning type boilers into powdered coal burning boilers, to Combustion Engineering Cp., 200 Madison Ave., New York, N. Y. Estimated cost $250,000.

Miss., Wesson—Kraft Cheese Co., 400 Rush St., Chicago, Ill., will soon award contract for the construction of a factory and boiler house, etc., here. Private plans.

Mo., Kansas City—G. H. McCandless, 400 Victor Bldg., will build an 8 story hotel at Ward Parkway and Wornell Rd. Estimated cost $500,000. A. A. Gentry, Dunlap Bldg., is architect. Work will be done by day labor.

N. Y., New York—J. H. Carpenter, 522 5th Ave., plans the construction of a 12 story co-operative apartment building at Madison Ave. and 89th St. Estimated cost $2,000,000. J. E. R. Carpenter, 598 Madison Ave., is architect.

N. Y., New York—Eton Holding Corp., c/o H. S. and S. O. Crystal, 47 West St., will receive bids to close Dec. and Jan. for a 15 story apartment building at First Ave. and 55th St. Estimated cost $1,300,000. G. & E. Blum, 415 Lexington Ave., are architects.

N. Y., New York—L. E. Kleban & Sons, Inc., 1440 Broadway, will receive bids about Dec. 1 for the construction of a 6 story apartment at 166th St. Grand Concourse and Walton Ave. Estimated cost $800,000. A. J. H. Leuchtag, 1385 Broadway, is architect.

N. Y., New York — Namalc Realty Co. Inc., is receiving bids for a 15 story apartment building including electric refrigeration system, elevators, etc. Estimated cost $800,000. Sugarman & Berger, 345 Madison Ave., are architects. C. Mayer, 31 Union Sq., is engineer.

N. Y., New York—Neurological Institute of New York, 149 East 67th St., awarded contract for a 14 story hospital at 193rd St. and Fort Washington Ave. to Marc Eidlitz & Sons, 41 East 42nd St. Estimated cost $1,250,000.

N. Y., New York—Printarts Building, Inc., c/o H. I. Oser, 1440 Broadway, Archt., awarded contract for an 18 story loft building at 228 East 45th St. to Magoba Construction Co., 103 Park Ave. Estimated cost $2,000,000.

O., Dayton — Syndicate, c/o W. W. Ahlschlager, Inc., 65 East Huron St., Chicago, Ill., Archt., is having plans prepared for a 6 story theatre and office building here. Estimated cost $2,000,000.

O., Youngstown — Youngstown Hospital Assn., plans the construction of a hospital on Gypsy Lane. Estimated cost $1,500,000.

Okla., Tulsa — Oklahoma National Gas Co., 117 West 4th St., awarded contract for a 10 story office building at Boulder St. to Shallenberger Construction Co., 1631 East 6th St. Estimated cost $500,000. Steam heating system, etc. will be installed.

Ore., Portland—U. S. Veterans' Bureau, 791 Arlington Bldg., Washington, D. C., will receive bids until Dec. 29 for a group of hospital buildings including ice and refrigeration plant, etc. at Sam Jackson Park and Marquam Hill here. Estimated cost $1,350,000.

Tex., Del Rio—Central Power & Light Co., Frost Bldg., San Antonio, is having preliminary plans prepared for the construction of a power plant and dam on Devils River here. Estimated cost $500,000. Private plans.

Tex., Del Rio—H. B. Jones, has acquired the waterworks plant of the East Side Water Co., and plans extensions and improvements including pumping equipment, etc. Estimated cost $30,000.

Tex., Nocona — Texas-Louisiana Power Co., A. P. Barrett, Gen. Mgr., Fort Worth Club Bldg., Fort Worth, is having preliminary plans prepared for a 150x250 ft. power plant, 3,600 hp. capacity, here. Estimated cost $325,000.

Tex., San Antonio—Interstate Amusement Co., c/o K. Hoblitzelle, will receive bids about March 1 for the construction of a theatre including refrigerated air cooling system, boilers, elevators, etc., on Houston St. Estimated cost $2,500,000. J. Eberson, 212 East Superior St., Chicago, Ill., is architect. Type of heating system not decided.

Wash., Seattle—F. A. Naramore, Central Bldg., Archt., will receive bids about Dec. 5 for the construction of a high school including boiler room at Highland Pl. and Galer St. for Seattle School Dist. No. 1. Estimated cost $300,000.

Ont., Fort Erie—Fort Erie Artificial Ice Co., is having plans prepared for the construction of an artificial ice plant on Douglas St. Estimated cost $175,000. A. W. Connor & Co., Metropolitan Bldg., Toronto, is engineer.

Ont., Hamilton—Hamilton General Hospital Board, Barton St. E., plans a 5 story addition to hospital including steam heating systems, elevators, etc. Estimated cost $700,000. G. T. Evans, 6 Hughson St., is architect.

Ont., Hamilton — McMaster University Board, 273 Bloor St. W., Toronto, has acquired a site and plans the construction of a group of college buildings including steam heating plant here. Estimated cost $1,500,000. Architect and engineer not selected.

Ont., Toronto—Canadian Paperboard Co., H. O. 2 Leigneurs St., Montreal, Que., awarded contract for the construction of a paperboard mill including boiler plant, etc. on Commissioners St. to W. J. Trimble, 73 Adelaide St. W. Estimated cost $1,000,000.

Ont., Toronto—Yolles & Rotenberg, Federal Bldg., is having plans prepared for the construction of a 20 story office building including steam heating system, elevators, etc., at Bay and Richmond Sts. Estimated cost $1,000,000. Chapman & Oxley, Northern Ontario Bldg., are architects.

Ont., Toronto — King-Adelaide Holding Corp., H. F. Williams, King Edward Hotel, is having sketches made for two 27 story and one 40 story office buildings at King and Adelaide Sts. Estimated cost $30,000,000. C. B. Dolphin, 10 Leader Lane, is architect.

Que., Montreal — Bell Telephone Co., Beaver Hall Hill, plans the construction of a 20 story office building. Barot & Bradkader, Canada Cement Bldg., are architects.

Que., Montreal — Railway Exchange Building, Ltd., 232 St. James St., awarded contract for an 11 story exchange building on Craig St. W. to Quinlan, Robertson & Janin, 702 Sherbrooke St. W. Estimated cost $670,000.

Ont., Toronto — R. Hunter, National Bldg., is having plans prepared for a 12 story office building including steam heating system, elevators, etc., at College and Bay Sts. Estimated cost $1,000,000. N. A. Armstrong Co., Ltd., 7 King St. E., is architect.

Equipment Wanted

Boiler, Pump, Etc. — Alexandria Water Co., U. S. Lambert, Pres., Alexandria, Va., will receive bids until Dec. 12 for a steam boiler, turbine driven pump with condenser, water power driven pump, feed water pumps, etc. for proposed pumping station.

Boiler and Turbine—West Texas Utilities Co., Abilene, Tex., will soon receive bids for a boiler and 6,000 kw. turbine in proposed power plant at San Angelo, Tex.

Boilers, Pumps, Motors, Etc.—Canadian Paperboard Co., H. O. 2 Leigneurs St., Montreal, Que., plans to purchase boilers, pumps, electric motors, turbo-generator, etc. for proposed paperboard mill at Toronto, Ont. Estimated cost $1,000,000.

Engine—Austin Ford & Son, 73 Main St., Cambridge, Mass., plans to purchase a double drum hoisting engine, gasoline driven.

Engines and Generators—City of Stillwell, Okla., plans to purchase two 200 hp. Diesel engines and generators for municipal electric light plant.

Motor Generator Sets—Bureau of Yards & Docks, Navy Dept., Washington, D. C., will receive bids later for motor generator sets and switchboard for Navy Dept., Brooklyn, N. Y. Former bids rejected.

Pump, Motor, Etc.—City of Dorris, Calif., is receiving bids for furnishing and installing a 300 g.p.m. multistage centrifugal pump direct connected to a 20 hp. vertical motor for proposed waterworks improvements.

Pump and Motor—City of Depew, Okla., plans to purchase a 50 g.p.m. deep well pump and motor for proposed waterworks improvements.

Pump and Motor—City of Bristow, Okla., plans to purchase a triplex pump and motor for proposed waterworks improvements. Estimated cost $50,000.

Pumping Equipment—City of Cabool, Mo., plans to purchase pumping equipment, etc., for proposed waterworks improvements.

Pumping Equipment, Etc.—City of Mangum, Okla., plans to purchase pumping equipment, etc., for proposed waterworks improvements. Estimated cost $75,000.

Pumping Equipment, etc.—City of Morgantown, Ind., will receive bids about Dec. 1 for pumping equipment for proposed waterworks system. Estimated cost $30,000.

Pumping Units—Brazos Valley Irrigation Co., Sugarland, Tex., plans to purchase and install pumping units in connection with proposed irrigation project at Richmond, Tex. Estimated cost $100,000.

Pumps and Electrical Equipment—F. C. Herzmalhalch, Clk., Fullerton, Calif., is receiving bids for furnishing and installing booster water and deep well water pumps, electrical equipment, etc., for proposed waterworks improvements.

Refrigeration and Ice Handling Machinery—A. Legasse, 2147 Pleasant St., Fall River, Mass., plans to purchase refrigeration and ice handling machinery for proposed ice house and refrigeration plant at North Dartmouth, Mass.

Transformers—W. A. Price, Clk, Redwood City, Calif., plans to purchase three 15 kw. and one 20 kw. primary transformers, 2300 v., 60 cycle.

Transformers, Switching Equipment, etc.—Dominion Power & Transmission Co., 128 King St., E., Hamilton Ont., plans to purchase transformers, switching equipment, etc., for proposed electric sub-station. Estimated cost $100,000 to $150,000.

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